AGRICULTURE FOR COMMON SCHOOLS

FISHER AND COTTON

E. B. Babcock


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AGRICULTURE FOR COMMON SCHOOLS

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BY

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WITH MANY ILLUSTRATIONS

CHARLES SCRIBNER'S SONS
NEW YORK:::::::::::::::::::::::::1909

ACKNOWLEDGMENTS

The authors wish to acknowledge their obligations for valuable criticisms and suggestions to the following members of the faculty of Purdue University: J. H. Skinner, Dean and Professor of Animal Husbandry; W. C. Latta, Professor of Agriculture and Superintendent of Farmers' Institutes; James Troop, Professor of Entomology and Horticulture; A. T. Wiancko, Professor of Agronomy; O. F. Hunziker, Professor of Dairying; W. W. Smith, Assistant Professor of Animal Husbandry; S. D. Conner, Instructor in Agricultural Chemistry; and Otis Crane, Instructor in Poultry. Thanks are also due to Miss Sarah E. Cotton, State Department Public Instruction, Indianapolis, Ind.

Credit for cuts loaned is given either in connection with the illustrations or in the List of Illustrations, for all of which the authors feel themselves deeply obliged.

M. L. Fisher.
F. A. Cotton.

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INTRODUCTION

While it is not the province of the public schools, as at present organized, to teach the trades, it is their privilege and their duty to put the child in intelligent touch with the life about him and to use all of the means at hand in the process of education.

Much has been said about the tendency among boys to leave the farm for the town, and many attempts at explanation and justification have been made. While it is perfectly proper for the boy to leave his father's farm and seek his fortune in a crowded city, sometimes he has gone with the mistaken notion that he could substitute wit for work in life's contest, or because of a lack of appreciation of the dignity of labor. Sometimes, also, he has gone because he has failed to see his opportunities on the farm. The fact that he has not always bettered his condition has suggested a possibility of bringing about at least a more intelligent consideration of the question.

With the lessening of distance between town and country by telephone, interurbans, rural routes, with the conveniences of life brought to the very door of the farmer, with much of the drudgery of farm life removed by machinery, it looks as though the tide might turn from town to country, or at least as though the exodus from the farm might be stayed.

AGRICULTURE THE DOMINANT INTEREST

An essential factor in education, which for the most part has been overlooked, is to be found in the environment of the child. One's power of interpretation is bounded by his experience, and yet we have gone on trying to fit a strange world down on to the child. We have expected him in some way or other to understand language and solve problems that are entirely foreign to him. This is neither good pedagogy nor good common sense. *The school work must be based upon what the child brings to school with him.* His life, his home, his vocabulary, his experience in the shop, in the quarry, on the farm, must furnish the concrete illustrations of the truth to be taught. It is the thing about which the child knows that interests him and that becomes the best means of interpretation.

The teacher, therefore, must be a student of community life as well as of text-books. He must be familiar with the institutions and interests of the community. He must know what the children know, how they think, and in what terms they express themselves.

Any new truth which the child gets must be related to what he already knows. The closer the teacher gets to the real experience of the child the more likely he is to awaken a live interest. In a rural community agriculture is the dominant industry. It determines the modes of life, the ways of thinking, and the basis of comparison. Therefore the problems in arithmetic can be more readily comprehended if they are cast in terms of the farm. The dominant industry or interest is the key that must unlock new truth.

Arithmetical truth must be cast in the concretest terms

possible. A little local coloring often takes the problem at once out of the realm of the strange. The actual market price of a commodity, with the actual amount bought or sold by an actual person, may transfer a problem from text to life. Language work becomes at once interesting if based upon actual experience. The child cannot write on abstract themes, but he can tell what he knows and he can be taught to tell this well. In geography it is the things about him that interest him, and through these alone he can interpret things that are foreign. With the presentation of every lesson the skilful teacher will seek the things at hand that may be the best media of interpretation.

Of course this calls for a complete knowledge of the community. The teacher should know the district in every detail—its extent in every direction; its earth facts, such as streams, hills, valleys; its farms; its houses; its acreage in wheat, corn, and oats; its officers, and its religious life. These things he can use in his work to great advantage, in concrete application of the principles he is trying to teach. If he knows something of agriculture his work in a rural community will be much easier. If his knowledge is scientific, so much the better. Certainly he cannot hope to deal in an intelligent way with the problems of a community with which he is unacquainted.

DIGNIFY WORK AND CREATE RESPECT FOR INDUSTRY

But aside from making the work concrete the dominant community interest may be made to serve another purpose. It may dignify work in general by creating respect for the industry in particular. Somehow the things at hand are not

appreciated. Farm life is not attractive to the boys and girls, and they turn their eyes toward the city. The occupations of the fathers do not appeal to the sons. There is a belief that something better is to be found, and so there is a lack of respect for the calling of the father. Furthermore, there is a lack of respect for manual labor and a belief that education can make it possible to live without work. As most of the boys and girls will be compelled to work with their hands, they should be taught early that labor is honorable and that idleness is disgraceful. By using the dominant industry the teacher can create a respect for it and at the same time show its possibilities. It can be shown that brain and muscle can accomplish just as much on the farm as in the city and that the chances for success are greater. It may not be the province of the public school to teach any trade or industry as such, but it is the province of the school to teach the boys and girls how to work and to put them in the path of honest living. *This is the purpose of the work in agriculture.*

SUGGESTED COURSE

The work offered in this text is intended for the children in the seventh and eighth grades and in the first and second years in the high schools. The text may be used to advantage as a reader in the sixth grade. When the course of study is too crowded the work may be taken three or four times a week, supplementary to nature study, or it may be taken before or after school.

This is a suggestion of what may be done by live teachers in the district schools and in the country and town graded schools. The work should be done in connection with arith-

metic, spelling, language, geography, etc. These suggestions carefully worked out in the grades indicated, followed by a study of this book, will put the children in sympathetic touch with the community; it will inspire them with respect for honest labor of all kinds, and show them that there is a demand for brains on the farm.

For an application of the principles above discussed the teacher is referred to the section, "*Education and Agriculture*," in the Appendix.

AGRICULTURE FOR COMMON SCHOOLS

SECTION I—SOILS

CHAPTER I

THE ORIGIN OF THE SOIL

In a study of agriculture the soil should first claim our attention. It is the foundation of all our study. Should we study farm crops we need to know what kind of soil is suited to each and how it should be handled to get good results. When we study the growing of fruits and vegetables we are interested in knowing, first of all, what kind of soil is best for each. In dealing with animals we are concerned about their food and that brings us back to the soil in which the plants producing the food were raised.

Making Soil.—1. *Weathering.*—We have learned from our geographies that at one time early in the history of the Earth it was a mass of melted matter. After a time it began to cool, and the outside of the ball hardened into rock. The seasons kept on changing, the rain descended and the temperature varied from time to time. The changes were more than the solid rock could stand and it began to crumble. Soil was formed. The action of the air and the weather upon the earth crust is called weathering. The

weathering of rocks has been the source of most of what we call soil. This process is still going on. The small pieces of gravel in the soil (in our fields) are being made smaller each year by the wear and tear of the winds and rain and by the freezing and thawing of winter. Wherever a gravel pit or stone quarry is opened many boulders and pieces of rock are thrown aside. The next spring after these have been exposed many rocks will be seen to be crumbling, while others do not seem to be affected. Some rocks are more easily broken up than others, but all will yield in time.

2. *Plants.*—Growing plants have had much to do in making soil and are still exerting an influence on the breaking down of rocks. We have all seen moss and lichens growing upon large boulders. In some cases there are two or three inches of material on the boulder. These plants are attacking the rock by means of the acids excreted from their root-like parts. The carbonic acid produced by the decay of the dead parts also tends to break up the rock. Sometimes the amount of material on the boulder is deep enough for large plants to grow in it. Then the decomposing action is all the greater, because of the greater activity of the real roots. Of course, all the action is very small for any one year, but when carried on for many years it amounts to a great deal. The material on the boulder is real soil, but in most instances it has been derived from the rock and the decayed vegetation.

We must not forget also that if there is ever so small a crack in the rock the tiny roots of plants will work their way into it and make it larger and so let in the water which we shall see helps to tear the rock apart. The writer has seen a large boulder weighing several tons split in two pieces and a tree

growing up between them. When this tree was young the crack was small, but as the tree grew the roots spread the crack wider and wider. Most of us have seen brick and cement sidewalks made uneven by the roots of trees growing under them.

Sometimes plants grow year after year in swampy places or in shallow ponds. At the end of summer the plants die down and fall to the ground or into the water. The next year a new growth of plants comes up and dies down again in the autumn. After this process has continued for many years there is quite an accumulation of vegetable matter on the ground or in the pond. This rots more or less and comes to be a kind of soil. If the rotting takes place under water, in which case it will not be very complete, peat is formed. Peat is generally rather solid and shows the original shape of the plants. It is on the road to form coal. But if the vegetable matter is exposed to the air and is sometimes water-soaked, and sometimes dry, it decays completely and forms muck. Muck is generally soft and spongy and does not show any trace of what it was formerly. Frequently muck has a good deal of sand and clay mixed with it by water which washes sand and clay particles over the vegetable matter.

3. *Water.*—Water has a great deal to do with the making of soil. Some rocks are porous and let a good deal of water soak into them. When the water freezes it bursts the rock, which gradually crumbles. Water will also dissolve some of the material of which the rock is made and in this way weakens its structure.

Doubtless we have all seen the water in a shallow stream rolling the gravel stones along on the bottom. As these pebbles roll along and strike against each other they knock off

corners and become smaller and smaller until they are nothing but sand. The parts rubbed off are very small and are carried into still water where they sink to the bottom, and when the stream changes its course they appear as real soil.

Perhaps the most noticeable action of water is when it works in the form of ice. We have seen cakes of ice all covered with mud floating down stream in the spring. We have seen, too, where ice cakes have struck trees and knocked off the bark. We are told by geologists that centuries ago all of the North American continent as far south as the Ohio and Missouri rivers was covered by ice to a great depth. The ice moved slowly down from the north like a great river and carried everything before it. It gathered up great rocks, and shoved them along and rubbed them over other rocks. Of course, when these rocks were ground against each other pieces were broken off which were carried along and ground on other rocks, until great quantities were crushed into fine powder which we now call soil. All over the region covered by the glaciers are to be found large boulders which escaped crushing and were left behind when the ice melted. These boulders are nearly always rounded, owing to their being rolled over and over and coming in contact with other rocks.

4. *Animals.*—While the dead bodies of animals contribute something toward the making of soil, the work of living animals is more noticeable. When such animals as gophers, prairie-dogs, wood-chucks, rabbits, crayfish, earthworms and ants burrow in the earth and throw out raw subsoil and small pieces of rock they are helping to make soil, for this raw material will be acted upon by freezing and thawing, and the roots of plants, and very soon will become, like the surface soil, fit to produce crops.

5. *Wind.*—The wind does its greatest work in distributing soil, but it has a part in the making of it as well. Where particles of sand are blown against solid rock, the solid part is gradually worn away and becomes soil. The friction between the rock and the sand which is being blown about has a tendency to rub off pieces, just as is the case in the bottom of the stream.

From the above we see that there are many agencies at work making soil. These have been working and will continue to work for centuries. It is likely that they are as active now as they ever were and soil is being made just as fast now as it was centuries ago. We shall see in the next chapter how much of the soil is wasted.

6. *Distribution.*—The greater part of the soil that we see in the fields has not always been there. In that part of the country which was once covered by glaciers most of the soil has been brought from some other place. South of the region covered by ice much of the soil has been formed from the rock underlying the region. However, little of the soil lies where it was formed, but has been moved by water and wind. Soils may be divided into two classes: *sedentary* and *transported.* Where the natural rock has decayed and the soil has gradually become deeper and deeper we have sedentary soils. Muck soils belong to the sedentary class because they are found in the place where they have been formed.

Transported soils are found everywhere. Water is one of the greatest agencies in carrying soil from place to place. We see its work along every stream wherever the bank is low enough to allow overflow. When it rains some water generally runs off the sloping parts of the fields and finds its way

into the streams. As it runs down over the land it washes loose and carries along many particles of soil. When these little streams come together in a larger stream the soil which they have carried along makes the water muddy. The large stream flows along, and if the rain has been a heavy one it may overflow its banks in the low places and spread out over the "bottom." When the water comes to a standstill the fine particles of soil settle out, and after the water goes down they remain behind as a thin layer over the land. Many creek and river bottoms have been built up in this way. Such soil is called *alluvial* soil. If the stream does not overflow, it may carry the fine particles along until it reaches the gulf, bay or ocean. Then, in the still water, they settle and form the deltas which are common at the mouths of many large rivers. The Mississippi and Amazon rivers deposit enormous amounts of soil in this way.

When this thin layer of mud is deposited over fields along the streams it is generally beneficial, especially if the overflow comes when there is no crop on the land. Farmers say that an overflow is as good as a covering of manure. This is because the particles of soil are the very richest part of the land from which they were washed. The Nile valley is enriched every year by the overflow of the Nile which brings down soil from its mountain sources.

Glaciers have had much to do with transporting soil. The country over which the glacier has passed has spread over it after the ice melts a large amount of soil carried from other regions. Sometimes this is as much as five hundred feet deep, but on an average about thirty to fifty feet. Water again has had a good deal to do with washing these drift soils about and sorting them. Most of the gravel and sand

banks are the result of the water sorting out the finer particles, carrying them away, and depositing the coarser sand and gravel in depressions.

The wind has had a good deal to do with transporting soil. We have seen the wind drifting snow in the winter time. Just so it drifts soil in many parts of the world. The material carried is usually sand and forms sand dunes. Along the southern border of Lake Michigan in Indiana are many

I. LAND DAMAGED BY WASHING
By courtesy of the Indiana Experiment Station

large sand dunes which have buried considerable areas of forest. Such land in its present condition is worthless for farming purposes. All wind-carried soils, however, are not worthless. In some parts of this country there are large areas composed of very fine particles, quite deep and fertile. These wind-formed soils are called *loess* soils. They are found mostly west of the Mississippi River.

We should notice here that the soil is likely to be washed away. Some soils wash more than others. Soils composed of very fine particles wash most readily, because the rain water

does not soak into them quickly but accumulates on the surface and runs off in little streams, carrying the fine top soil with it. This is very bad for the farmer, for it is the very best part of his land which is being carried away. In some places hundreds of acres of land have been ruined by washing.

CHAPTER II

THE MAKE-UP OF THE SOIL

Kinds of Soil.—If we take a small quantity of soil in our hand and look at it carefully, we shall be able to see with the naked eye that it is made up of small particles which look like little stones. These particles are pieces of decayed rock and range in size from those easily seen down to the minute pieces which appear to us as dust. The bulk of the soil, unless it be muck, is made up of these small particles or grains. Besides these small grains of rock there are many particles which seem to be pieces of roots, stems or leaves, and such they are. The rock particles are called the *mineral* matter of the soil and the pieces of roots, stems and leaves the *organic* matter. In muck soils the organic matter predominates.

When the rock particles are large enough to be seen easily they are called sand. The very fine dust-like particles are called *silt* and *clay*, the very finest being clay. It takes a microscope to see the finest sand grains and to tell the silt from the clay. When the sand grains are quite prominent the soil is a sandy soil. If no sand particles can be seen and the soil is quite floury when crushed, it is clay. Now, when the sand, silt and clay particles are mixed and not many sand particles can be made out, we have a loam soil. We have various names for soils, such as sandy, light sandy loam, sandy loam, loam, clay loam, heavy clay loam, and clay, all depending

upon the proportions of sand, clay and silt in the soil. The sandy loam, loam, and clay loam are the best soils for general purposes.

We must not forget that muck is called a soil, but it is not a soil like those mentioned above, for it is made principally from decayed stems and leaves. The sand and clay in it have been carried in by the water which stood on, or ran over, the swamp or lake before it was drained. If you were to take some dry muck, weigh it and burn it and then weigh the ashes, you would find that from two-thirds to three-fourths of its weight had burned away. If you were to burn a loam soil, you would lose hardly one-tenth of its weight, while there would be still less loss from sandy and clayey soils, showing that these soils do not have much organic matter in them. Muck soils are sometimes called *humus* soils and the vegetable matter in sands, loams and clays is called the humus. Real humus is vegetable matter so completely decayed that one cannot tell what it was like at first. It is very important that soils have a good supply of humus, as we shall soon point out. Most farmers are anxious to increase the amount of humus in their soils, and try to do so by hauling manure on the fields and by plowing under green crops like rye or clover, or the stubble from any of the farm crops.

Plant Food in the Soil.—Although the soil may be made up of what appear to be particles of rock with a few pieces of rotten roots and stems mixed with them, it contains the substances necessary to make plants grow and develop. There are about thirteen substances which seem to be more or less necessary for the plant, namely: hydrogen, oxygen, nitrogen, phosphorus (phosphoric acid), potassium (potash), calcium (lime), magnesium, iron, sulphur, sodium, silicon, and

chlorine. The humus of the soil contains a great deal of carbon, but the plant gets its carbon from the air through the pores on the leaves. Besides the above, there are some other substances found in the plant which come from the soil.

The substances mentioned above are called elements of plant food. They are dissolved in the water in the soil and enter the plant through the roots and are carried slowly up to the leaves. In the leaves they are acted upon by the sunshine and are united in various ways with each other and the carbon of the air to make the different compounds like starch, sugar, fat and protein which are found in the plant. Hydrogen and oxygen united form water, but hydrogen, oxygen, and carbon combined make starch, sugar, and cellulose, the last of which forms the woody part of the plant. Rankness of growth indicates an abundance of nitrogen; a pale color of the leaves shows need of iron; lime, phosphorus, and magnesium appear in the seeds quite largely; strong stems and a good heading out and earing out of grain plants show a sufficiency of potash. When the different compounds have been formed in the leaves they have to be moved to other parts of the plant, for instance, in the potato plant starch is moved down to the potato. Potash, magnesia, lime, and chlorine are important in these movements. Nitrogen, sulphur, and phosphorus are necessary for life processes to go on in the plant. The part which sodium and silicon play in the plant has not, as yet, been fully determined. In some cases they appear to be necessary, while in other cases they are not.

It has been shown by analysis that most soils contain enough of the different plant foods to furnish crops for hundreds of years. Professor King, of Wisconsin, has demonstrated that there is enough potash in the surface soil one

foot deep to last 1,521 years, magnesia to last 3,300 years, phosphoric acid to last 542 years, and nitrogen to last about 250 years, when properly farmed. This is doubtless true of a fairly fertile soil. Although there are such large quantities of these different substances in the soil naturally, the plant very often suffers from a lack of them. This is because they are bound up in the soil in such a way that the plant cannot make use of them. In such cases it is necessary to apply them to the soil in the shape of fertilizers, or steps must be taken to make what is in the soil available. The plant foods most often needed are nitrogen, phosphoric acid, potash, and lime. We shall speak of these again.

A great many persons believe that a chemist can analyze a soil and tell just what that soil will grow and what kind of fertilizers it needs. This is a mistaken notion. There are two kinds of analysis. One is a *chemical* analysis. In such an analysis the different kinds of plant food are determined and the amount of each. There is usually found to be plenty for all the needs of the crop. However, such an analysis cannot determine how much of these substances the plant can use when it grows in the soil, so that certain elements must sometimes be supplied in the form of compost or manures, even though the analysis shows an abundant supply in the soil. The other kind of analysis is called *mechanical*. In this analysis the soil grains are separated into groups of various sizes and the amount of organic matter is determined. Such an analysis tells something about the ability of the soil to hold water, and the ease with which it can be drained. It also gives an idea of how easy a soil will be to cultivate. If one knows something about the kind of land on which different farm crops grow well, he can tell from this

analysis about what crops will do well on this land. However, neither of these analyses is a perfect guide, and the only way to find out which crops will do well and which kind of plant food is lacking is to test the soil with different crops and different fertilizers.

Life in the Soil.—We are apt to think of the mineral and vegetable matter in the soil as being dead substances. However, there is a real life in the soil. There are many kinds of plants too small to be seen with the naked eye living in the dead organic matter and on the soil grains. These are called *soil bacteria,* and many kinds are known. Each kind has a work of its own to do. We do not know yet the real use of a great many of these bacteria. We know that there are some kinds whose business it is to make the vegetable matter decay and put the substances of which it was composed in shape to be used again for plant food. Other bacteria catch nitrogen as it circulates through the soil as air and hold it for the use of plants. Doubtless we have all seen the little knobs on the roots of red clover, beans, or some other plant that belongs to that group of plants which has blossoms like the garden bean or pea. Such plants are called *legumes.* The knobs on the roots are called *nodules* (See Fig. 20). In these nodules are many bacteria which take nitrogen from the air and give it to the plant, and also build it up into their own cells. (A bacterium has but one cell.) While the bacteria furnish nitrogen to the plant, the plant gives the bacteria such food as starch and sugar to live on. So it is that the plants and the bacteria are helpful to each other. When the clover or other legume dies, there is left for the next crop a great deal of nitrogen in the soil. As nitrogen is a costly plant food and very important, the farmer is always anxious to have a good

clover crop or a good crop of some other legume. It is the bacteria which make the clover crop such a desirable one. Bacteria do not live on the roots of any plants other than legumes. There are other bacteria, which do not live on the roots of any kind of plants and which catch nitrogen and hold it for the use of plants. All bacteria which have anything to do with gathering nitrogen are called nitrifying bacteria. They require proper conditions of temperature, moisture, air, and food to do their work well. The farmer who has ground well drained, manured, and cultivated helps the bacteria to do their work.

There are some bacteria which work well when the soil is too wet to cultivate, but they are not the helpful kind. Instead of gathering nitrogen they lay hold on those substances in the soil which contain nitrogen and let it loose so that it escapes from the soil as a gas. Such bacteria are called *denitrifying* bacteria. The farmer who does not have his land well drained and cultivated helps this kind of bacteria to work, and they do him no good.

CHAPTER III

PHYSICAL PROPERTIES OF SOILS

By physical properties are meant weight, color, temperature, and the way in which air and water circulate through the soil.

Weight.—The weight of a soil depends upon what it is derived from. A cubic foot of sandy soil will weigh more than a cubic foot of loam, and a cubic foot of loam is heavier than a like amount of muck. The sandy soil is composed almost entirely of hard flinty or quartz rock particles, which have very little vegetable matter among them. The loam contains, besides the quartz particles, many particles of rock not so hard nor so heavy. The loam has also much more organic matter in it than there is in the sand. Muck is rather light, because it is made up so largely of organic matter and has so little of rock particles. A cubic foot of dry soil will weigh about as follows: sandy about 95 to 100 pounds, clay 70 to 80 pounds, loam 65 to 75 pounds, and muck 30 to 40 pounds. Sandy soils are the heaviest of all soils by weight, but farmers speak of them as being *light* because they are easily plowed and cultivated; clay soils are said to be *heavy* because they are difficult to plow and cultivate.

Color.—The color of soils is variable and is not a very certain sign of their fertility. Sands are generally grayish or yellowish. Clays may be whitish, yellow, red or bluish.

These colors are generally caused by some chemical element in the soil, usually some form of iron. Loams and mucks are always dark colored, owing to the large amount of organic matter in them. We shall see that color has something to do with the temperature of a soil.

Temperature.—The temperature of a soil is very important, since it influences the sprouting of seeds and the growth of plants. Most farm seeds germinate best at temperatures between 70 and 80° F. Furthermore, their best growth takes place at temperatures equally high. Such seeds and plants as corn, melons and cucumbers require even higher temperatures. Dark colored soils are warmer than light colored, because the dark color absorbs more heat from the sun. Such a soil may be, according to Professor Brooks, of the Massachusetts Agricultural College, as much as eight degrees warmer during the hours of sunshine than a light-colored soil. A soil which has rather coarse grains will warm up more quickly than one having very small grains, because the coarse particles will draw the heat from the sun better than fine ones. This is one reason why sandy soils are warmer than others and are desirable for early vegetables. A dry soil is warmer than a wet one, hence drainage aids in warming a soil. A soil having a good deal of humus in it will tend to be cool because the organic matter holds water. However, the dark color of such soils by absorbing heat has a tendency to offset the cooling effect of the water. When land slopes to the east, south, or south-west, it is naturally warmer than land which slopes to the north or north-west, because the sun's rays fall more nearly straight on it.

Aeration.—It is necessary for the good of the plant that air circulate through the soil. The air furnishes oxygen to

the soil and this is useful in many ways. Oxygen is necessary for the sprouting of seeds and for the healthy growth of the roots, and it aids in many chemical changes in the soil whereby plant food is made ready. Bacteria must have it for their life and work. In any soil there are spaces without number among the soil grains. These spaces are called *pores*. If the grains are coarse, the pores are large; if fine, the pores are small, but more numerous. When these spaces are not filled with water they are occupied by air. This air is called soil air. If it did not move it would become foul just like the air in a closed room and just as injurious to the life of the soil as the foul air of the room is to persons in it. The movement of this air is brought about by the suction of the winds which blow over the land. This draws out some of the air in the soil and permits other air to enter. Where land is drained by tile ditches there is a movement through the lines of tile. When the land is soaked no air can circulate because the pores are filled. Soil having large pores, and soil cultivated until it is loose, permit a freer circulation of air than compact soil with small pores. A too free circulation is not desirable, because it will dry the soil too much and will also cause the vegetable matter to be burned out too fast.

Water in the Soil.—The water in the soil has several important parts to play. 1. It keeps continually dissolving small amounts of the soil grains. This dissolved material furnishes the ash of plants. 2. By the constant evaporation of water from the leaves the temperature of the plant is kept from rising too high in hot weather. 3. By the movement of water in the soil, of which we shall soon speak, the dissolved material is brought in contact with the roots of the plant. 4. All the live cells of the plant are made up largely of water.

2. PLOWING BY STEAM

Plowing by steam has become a popular method on many large farms, especially in the West and North-west

This water furnishes a means for the carrying on of the life processes of the plant. 5. Some water is actually built into the tissues of the plant. Even though a piece of vegetable matter seems quite dry, there is still moisture in it. This may be easily noticed in the burning of a match.

Kinds of Water in the Soil.—Even though the soil be as dry as the dust in the road, it has moisture in it. If some of this dry soil were heated at a boiling temperature for two hours it would be found that the soil had lost weight. The moisture contained in such dry soil is called *hygroscopic* moisture. It exists there as a very thin film around each soil grain. If you can think of a marble inside of a soap bubble and the bubble shrinking down upon the marble you will have a good idea of how the hygroscopic moisture exists in the soil. Plants growing in the soil cannot make any direct use of hygroscopic moisture.

When the soil is in good condition to cultivate it contains considerable moisture. The films around the soil grains are thicker and some of the small pores between the grains are filled with water. Such water is called *capillary* water and is useful to plants. When all the little spaces are filled with water and the soil is so wet that water is almost ready to drip from it, the soil is said to be *saturated.* In this condition it is too wet for farm crops to grow well. It must never be stirred when it is so wet. Soil is in the best condition to farm when it contains about one-half of the amount of moisture which it contains when saturated.

The water which oozes out of the soil and runs away in the tile drains is called *free water* or *hydrostatic* water. The water which runs down the slopes of the field without soaking into the ground is also free water and is generally called *surface*

water. Free water is not only of little use to the plants, but instead it carries away particles of rich soil when it runs off the surface, or dissolved plant food when it escapes in drains.

Capillary Movement of Water.—In most soils there is a point more or less distant, usually six to thirty feet, from the surface where the spaces between the soil grains are filled with water, that is, the soil is saturated. This is called the standing water or *water table,* and it extends beneath the surface at variable depths as a sheet of water. It is this water table that we drill or dig into when, in putting down a well, we say we have struck a "vein" of water. The water table follows the general outline of the surface soil and has its high and low places just like the land.

When the soil near the surface begins to get dry, water creeps up over the particles of soil in the subsoil toward the surface and tends to renew the water there. This is called *capillary movement.* The cause of the loss at the surface is the drying action of the wind and sun called *evaporation,* and the loss by evaporation from the leaves of plants called *transpiration.* Now the water rarely moves up fast enough to keep up the supply at the surface, so that the ground gets quite dry after a time, but by cultivation we can help to keep up the supply. We shall explain this presently.

Capillary movement takes place differently in different kinds of soil. In coarse grained soils like sandy soils it moves faster, but not through so great a distance. A clay or loam subsoil is the best to supply moisture to crops in dry seasons, because in such soils the capillary water will move through a greater distance than in any other soils. This is because the grains in these soils are quite small and the films on their surfaces are comparatively strong. These films make a strong

pull on the free water below and can raise it to quite a height. This capillary movement does not necessarily always move upward. In general it moves toward the point where the soil is the dryest. If the ground becomes quite dry and there comes a heavy shower, the capillary movement may be downward, the tendency being always to equalize the thickness of the film around the adjoining soil grains.

Percolation of Water.—By percolation is meant the downward movement of free water through the soil. Some of the spaces between the soil grains are too large to hold water by capillarity, so that whatever water comes to them is allowed to pass on. In this way water which falls on the land as rain soaks into the soil and moves downward until it comes to the water table. It is plain that if the soil particles are coarse the spaces between them will be larger than if the particles are fine, so that in the coarse soil water can percolate more readily than in the fine-grained soil. For this reason sandy soils allow the rains to soak into them and drain away more easily than clay soils. The way in which water percolates through soils determines the amount of tile draining that is needed. Clay soils need more draining than any other, because water moves through them very slowly.

Power of Soils to Retain Moisture.—When soils have been saturated and then allowed to drain without any evaporation from the surface they are still found to hold different amounts of water. Taking sandy, loamy, and clayey soils it will be found that this amount will vary in the order that the soils are named, the sandy holding the least and the clayey the most. The amount held is partly dependent upon the size of the soil grains and partly upon the amount of organic matter in the soil, so that loam often holds more than clay.

The sands have the coarsest particles and the clays the finest, while the loams have fine particles and the most organic matter. Muck soils, being so largely vegetable matter, hold more water than any other kind. Soils that are loose hold more water than compact soils. However, some of the coarser sands hold more water when packed than when loose. When a soil is packed the very finest particles are forced into the smaller capillary spaces and so shut up some of the space that might be occupied by water. This is the case in packed clays and loams. When a coarse soil is packed the smaller particles are forced into those smaller spaces which are too large to hold capillary water, making them smaller and enabling them to hold more moisture than if they were left loose. As an illustration of how much water per cubic foot loose soils will hold we may take the following figures: sandy, 24 pounds; clay, 28 pounds; loam, 32 pounds; muck, 40 pounds. If we take the weight of a cubic foot of water to be 62.4 pounds, then an inch of rainfall will weigh one-twelfth of 62.4 pounds, or 5.2 pounds. Then if the figures above be divided by 5.2 we have the following number of inches of rainfall for a cubic foot of each soil: sandy, 4.6, clay, 5.4, loam, 6.1, and muck, 7.7. Since all soils vary somewhat the above figures are correct only for the particular soils tested, but they do show how the kinds of soils differ. We must remember that the above figures show what is in the surface foot. The second and third and fourth foot will contain about as much, usually a little less, depending upon the size of the soil particles, so that the total amount of water held in the soil is a great deal. The roots of plants feed mostly in the first two feet. If we could save for use all the water that a soil will hold we should have plenty for all the needs of the crop. However, we have said

that only about one-half of the total that the soil will hold is desirable at any one time. We shall learn something more in another chapter about holding the water for the use of the crops.

Movements of the Plant Food.—We have said that the plant gets from the soil all its food except carbon. We have also said that the water in the soil is continually dissolving small amounts of the soil grains and other chemical compounds in the soil. All food for the plant must be in solution, that is, dissolved in the soil water. The carbon, as carbon dioxide, is a gas in the atmosphere and gets into the plant through the pores on the leaves. The dissolved materials have a tendency to distribute themselves equally through the soil water. The same thing happens if we put a lump of salt in a vessel of water. Although we slip it down in one corner of the vessel and do not stir the water it will not be long before the water on the opposite side will taste salty. The dissolved salt has spread throughout all the water in the vessel. This is called *diffusion.* This diffusion and the capillary movement of the water in the soil bring the dissolved material to the roots of the plant and the root hairs near the tip of each rootlet take in the plant food and pass it on through the roots, stem and branches of the plant to the leaves, where it is worked up into various products such as the plant uses to build up its structure and also to store away. The root hairs are tiny thin-walled cells. The cell wall does not have any openings in it that one has ever been able to find, but still water and the dissolved materials pass through it. This passage through a cell-wall, or membrane, is called *osmosis.* It is a kind of diffusion. Inside the plant the material has to pass from one cell to another by osmosis.

CHAPTER IV

DRAINAGE AND IRRIGATION

From what has already been said it is clear that the moisture in the soil is an important item. If a soil has too much moisture we try to get rid of the surplus by drainage; if it has too little, we apply water to the soil, that is, irrigate it.

Kinds of Drains.—All drains may be grouped in two classes—open and closed drains. Of the open drains we have (1) the surface drain, made by plowing a furrow up through the low place in a field to allow the water to run away. Sometimes these surface drains are made by plowing the field in narrow "lands," thus having many "dead" furrows. (2) The open ditch. This differs from the open drain only by being wider and deeper. The surface drain lasts only one year or until the field is plowed again. The open ditch lasts usually for several years. Muck beds are often drained by open ditches. In many parts of our country there are large open ditches put through by the authority of the county or state. These extend for miles in length and serve as an outlet for all other kinds of drains. They are frequently called county ditches. Sometimes they are called dredge ditches, because a dredge has been used for removing the dirt and making the channel.

By closed drain or under-drain is meant that kind of drain in which a trench or ditch has first been dug and some-

thing put into the bottom of the trench to form a passage-way for the water and then the trench filled up again. 1. The most common closed drain is the one in which tile is placed in the bottom of the trench to carry the water. 2. A box with open ends is frequently used to carry off the water. The box may be square or triangular. 3. Flat stones may be arranged so as to make a covered way for the water. 4. Two poles may be laid along the sides of the bottom close together and a third one put on the top of these to make an open passage. The poles will soon sink into the mud and stop up the passage-way. 5. The bottom of the trench may be filled with brush and these covered with straw or pieces of sod to prevent the loose dirt from washing in. The trench is then filled with dirt. All forms of under-drains described, except tile, are likely to be temporary and poor, and hardly pay for the labor of making them.

There are two great objections to open drains. 1. Open drains use up a good deal of land on which no crop is grown. If an open ditch is ten feet wide it does not need to be very long to use up an acre of land. Then, too, besides the open part there are the two banks on which we cannot raise anything. If such a ditch were tiled with large tiles it could be filled up and crops grown on it. 2. Open ditches are always getting filled up with grass, weeds, brush and mud. If hogs can get to an open ditch they soon work down the banks and fill it up. If open ditches are not kept cleaned out they are soon worse than useless.

When Drainage is Necessary.—Almost all of our farm soils are helped by drainage. Only sandy soils and those which have a gravelly or sandy subsoil do not need drainage. Of course the soil in the far west in what is called the

arid region does not need drainage. On the contrary, it needs watering. 1. All over the United States there are little ponds, swamps and marshes which need drainage. It is said that there are six hundred million acres of such land in the United States. This area, however, is growing smaller every

3. CROP FAILURE DUE TO LACK OF DRAINAGE
By courtesy of Prof. G. I. Christie, Purdue University

year, because great drainage operations are being carried on everywhere. Land values have increased so much that it pays to drain land now that a few years ago was thought to be worthless. 2. Besides this swamp land there is much farm land where there are low places in which the water stands a long time in the spring and after heavy rains, making the farmer late in getting out his crops, and often drowning out the crop after it is planted. 3. In almost any field there is

a low strip of land upon which the water from the higher ground runs, forming a natural drain for the surface water. Such "draws," as they are called, should be drained. 4. Much of our clay land dries off so slowly, because the water cannot soak down through it quickly, that it should be drained. A tile ditch through a knoll is often beneficial. 5. Along hillsides it frequently happens that the water oozes out very much as it does from a spring. A drain put lengthwise along the foot of a hill will be very helpful. 6. When such plants as sedges, rushes, and mosses come up naturally on land it needs draining. 7. Land that cracks open badly after drying out needs draining. Such land gets too hard and compact, and the cracking open breaks off the roots of plants growing in it.

Results of Draining.—The results obtained from draining are many. One of the most important is the greater amount of soil made useful to the plants. When plants grow on wet soils they nearly always have their roots near the surface. The plant then draws its food from the surface soil. None of our farm crops will grow with their roots extending into water. When the subsoil is quite wet early in the season, the roots all form in the upper layers of the soil. Later in the season, when the subsoil gets drier, the roots do not follow down after the retreating moisture, but remain near the surface. As the plant comes to full growth it draws so heavily upon the soil for moisture that the capillary movement upward does not supply enough for the plant's needs, and so the plant suffers. Now, had the land been drained so that the subsoil would have lost its surplus moisture early in the season, the plant roots would have formed lower in the soil and many would have reached down three or four feet or more.

By so doing they could draw upon the moisture in the lower layers and would not have to depend upon capillarity bringing the water so far. When we know that a corn plant coming into tassel uses nearly three pounds of water daily we see the importance of having moisture convenient for the plant roots. Not only does drainage give the roots a larger amount of soil from which to get moisture, but at the same time the roots draw plant food from a larger amount of soil. Because drainage gives access to more soil, we say that it deepens the soil.

Drainage has the effect of warming the soil. The evaporating of water is a cooling process. When there are no drains much of the surface water has to evaporate. This takes a good deal of time and keeps the land cold and wet. There is usually a difference of five to ten degrees between the temperature of drained and undrained soil in the same field. This makes a decided difference in the germination of seeds and the growth of the plants. It may be noticed in fields that corn comes up quicker and grows faster in the drier parts of the field. This is not entirely because the soil is looser and richer, but because it is warmer. Then, too, the summer rains soak quickly into a drained soil and are more fully used by the growing crops.

Several other results can be mentioned briefly. In drained soil bacteria are more active, making more plant food available. The bacteria cause the decay of the manure or other organic matter in soil, so that we get more good from the manure applied to the land. As the water finds its way through the soil to the tiles it leaves small passage-ways. This permits the air to come into the soil. We have seen in another chapter that this is desirable. Furthermore, when

the tiles are not draining they are filled with air so that there may be a circulation of air through the soil by way of the tiles. Another advantage in having the land drained is that it permits the farmer to get out crops earlier in the spring, and since the drained land is warmer they grow faster. So the farmer with drained land generally raises bigger crops and gets more returns from his land. Drained land is always easier to plow and to cultivate, so that such soil is tilled with less labor.

How to Drain.—Before beginning to drain a piece of land the farmer should look it over carefully to determine where the drain is to empty and in what places lines of tile are to be laid. Large areas should be surveyed. Generally there is one main line of large sized tile put through the lowest place in the field where the most water naturally runs. This line is called the *main*. Into the main from the sides run branch lines of smaller tile. These branch lines are called *laterals*. The slope of the land toward the place where the drain is to empty, or the *outlet*, is called the *fall*. This should be at least two or three inches per one hundred feet, and five to eight inches is considered about the best average. Larger tiles are generally used near the outlet than toward the upper end of the drain. The tiles in the laterals are not so large as those in the main. The size of the tile depends upon the extent of the system, the amount of water to be carried, and the fall. Professor Elliott, in Farmer's Bulletin 187, says that the tiles in the laterals should be 3 or 4 inches in diameter and that a 5-inch main (and its laterals) having a length of 1,000 feet and a fall of 3 inches per 100 feet will drain 25.1 acres. In a complete farm system of drains 2-inch laterals would be ample. The depth to which the tiles are put is not always the

same, but usually it should be 3½ to 4 feet. Such depth insures the quick drainage of the surplus water from that part of the soil in which the roots are mostly found.

After the trench is dug the tiles are laid end to end in the level surface of the bottom. Care must be taken that the joints fit closely so that soil will not wash into the tiles and clog them up. After the tiles are laid the covering of them must be carefully done, so that they are not displaced. It is helpful if an air vent is left at the upper end of the line of tiles. This is made by setting a couple of tiles on end, or by filling up the trench at this point with small boulders. These air vents give a better "draw" to the system. A screen of some kind over the outlet will prevent the entrance of rabbits or other small animals which might get fast and die and clog up the system. Draining costs from six dollars to thirty dollars an acre and every care should be taken to keep the system in good working order.

Irrigation.—Irrigation is artificially supplying water to the land. It is practised in places where there is little or no rainfall. It is also used to some extent in other regions in dry times, particularly in gardens and truck fields where the crop is very valuable. Irrigation is used quite extensively in rice growing.

Places where the rainfall is twenty inches or less during the year are called *arid;* if the rainfall amounts to twenty to thirty inches, the region is said to be *semi-arid;* where more than thirty inches of rain falls in the year we have a *humid* region. Parts of the following states need irrigation: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Of these, Nevada, Utah, Arizona, and Southern California are the dry-

est. A narrow strip lying east of these states is called the semi-arid region. It takes in parts of Kansas, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas. All the remainder of the United States in ordinary seasons is humid. In wet seasons many parts of the above-named states do not need irrigation. Besides the states mentioned, irrigation for rice growing is practised in Georgia, Louisiana, North Carolina, South Carolina, and Texas.

Irrigation has been practised in the Old World for hundreds of years. It seems that the Egyptians were the first to make use of this method of growing their crops, but all over South-western Asia also are the remains of great irrigation systems. Even to-day millions of acres are irrigated in India, Egypt, and Italy, and it is extensively practised in many other countries of the world.

The principal reason for irrigating is to supply the plant with the proper amount of moisture at the time when it needs it. In the arid region the plant needs moisture applied regularly. In the semi-arid region it is sometimes not necessary to apply any extra water. In the humid regions irrigation is needed only in periods of drouth. It must be understood that there is no definite division between these three large regions. They overlap each other according to the season.

The amount of water necessary to produce a crop is very variable. It depends upon the soil and the time of year when the rain falls. Even in those sections where irrigation is carried on most extensively, if the rain would fall at the proper season it would be sufficient, but frequently it falls during the cold time of the year when plants cannot use it. In parts of California it has been found possible to produce good crops

of wheat with a rainfall of only twelve inches per year. The fact that crops can be produced from a very few inches of rainfall when it is properly saved has led to what is called "dry" farming. This is carried on mostly in the semi-arid region. In dry farming the object is to stir the ground deeply so that it will take in all the rainfall and hold it for crops. A deep loose surface is kept over the fields to prevent any moisture from evaporating. By so doing good crops are produced where the rainfall amounts to from ten to twenty inches annually. So in the application of water by irrigation it has been found best to apply about the above amount and then give careful cultivation to save the moisture. The cost of irrigating is heavy, so that farmers try not to use more water than necessary.

Irrigation is used for other purposes than simply to supply water to the plants. It is sometimes used to carry dissolved plant food over the land. This is especially true where sewage water is spread over the fields. The water in rivers, and that from wells, too, usually has considerable plant food dissolved in it and, when spread over the land, adds fertility to it. Commercial fertilizers that are to be applied to a field are sometimes dissolved in the irrigation waters and so distributed.

Another use of irrigation is to rid the land of "alkali." The soil on large areas in the dry region of the West is filled with salts which are injurious to plants. Such lands are called "alkali" lands. It has been found that if enough water can be applied to such lands to produce percolation these salts will be dissolved and washed away, and the land made fit for crops. However, the water applied must be pure water free from any injurious salts.

It is impossible to give here all the details about irrigation, but the water is obtained either from streams, reservoirs, or deep wells. In our western states there are many streams which have their sources in the mountains and are fed by the snow on the peaks. As these streams flow out over the level country, ditches are dug leading out from the rivers into the fields that are to be irrigated. Smaller ditches run out from the larger ones to every part of the fields. The banks of the ditches are made higher than the rest of the land, so that when the water is dammed up in the ditch bank-full, places called "gates" can be opened in order to let the water flow over the field until enough is supplied. The gate can then be closed and the ditch dammed up further down and another gate opened and more of the field watered, and so on until all the land is watered. Sometimes the water is pumped out of the big ditches into the smaller ones. Where water is obtained from wells, it is raised by large pumps which can throw thousands of gallons in an hour. It is pumped into ditches and allowed to run out over the land as in the other cases. Irrigation from deep wells is especially practised in the rice fields of Louisiana, Texas, and Arkansas. Irrigation of rice is called "flooding." The water is turned on several inches deep and allowed to stand for a few days, then it is drained off. Rice lands are flooded two or three times during a season of growth. For all crops other than grain or grass crops it is necessary to stir the top soil as soon as dry enough after irrigation in order to keep the water from evaporating.

CHAPTER V

HANDLING THE SOIL

PLOWING, harrowing, rolling, disking, cultivating, and fallowing are called *tillage* operations and are used in the preparation of the soil for crops. Not all of these processes are used for every crop. The kind of soil, the nature of the season, and the crop to be planted—all these have something to do with the amount of preparation given the land. For example, the raising of wheat does not call for any cultivation. Then, too, it is not a good thing to roll land in a wet season. Again, oats and other spring-season grains are frequently sown without plowing the ground.

Parts of the Plow.—The *beam* is the principal part of the plow. To it all the other parts are fastened and to it the horses are hitched by means of the *clevis* to pull it through the ground. The beam may be made of wood or iron. The *share* is the part which slips along on the bottom of the furrow and cuts the soil loose. It is sometimes called the "point." It is made either of cast iron or wrought iron. The cast-iron point is most in favor for fall plowing, because it is very hard and does not get dull so soon as a wrought-iron point. The *mold-board* is the curved part just above the share and over which the soil is pushed when the plow goes through the ground. It is curved so that the soil is turned over by the time it has slipped over the mold-board. If the mold-board has a long

curve, the plow is said to be a sod-plow, because it will turn the sod over well. If the mold-board has a short, steep curve it is called a "bold" mold-board, and the plow is a good stubble-plow, because it pulverizes the soil while turning it over. The part which slips along next to the unplowed land is called the *land-side.* The *handles* are the parts that the plowman uses to guide the plow. The *colter* or *cutter* is a sharp bar of metal fastened to the beam or to the plow-point,

4. A WALKING BREAKING PLOW

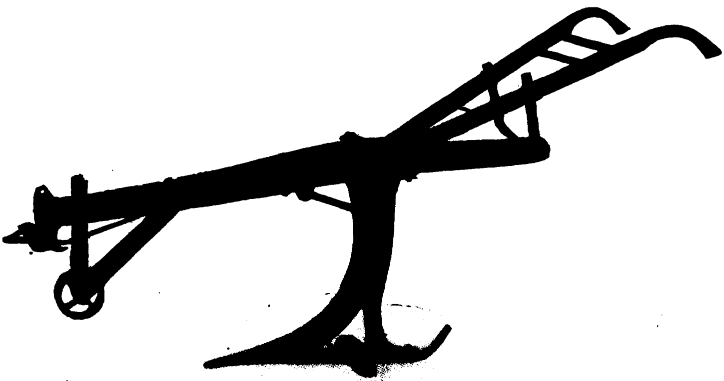
which pushes ahead of the mold-board to cut the soil from top to bottom. The colter is not absolutely necessary. Sometimes instead of a colter shoving through the soil there is a solid sharp wheel fixed to the beam which cuts the soil. This is called a *rolling-cutter.* The *shank* is a bar extending straight down from the beam and to it the share, mold-board and land-side are fastened. It helps to give stiffness to the plow. The *jointer* looks like a little plow fastened to the beam. It takes the place of the colter and turns a narrow and shallow slice of soil in front of the main slice. It is particularly useful in the turning under of trash of all kinds and especially

useful in plowing sod. The *beam-wheel* is a wheel fastened at the end of the beam where the team is hitched. It serves to steady the plow. It is not found on all plows.

A *right-hand* plow turns the soil to the right, a *left-hand* plow turns it to the left. One kind is as good as the other. The plow is regulated usually by the clevis, which can be moved from side to side and up or down. In the case of a left-hand plow, if the clevis is moved toward the right the plow will not turn so much soil, but if it is moved toward the left the plow will turn a wider strip of land. If the clevis is moved down the plow will run less deep, but if it is moved up the plow will go deeper. The soil that is turned over is called the *furrow-slice.* Several furrow-slices together make the *land.* Where a strip of ground or a field is finished there is a furrow or ditch called a *dead-furrow.*

Kinds of Plows.—The kind of plow described above requires the plowman to walk after it. It is called a *walking-plow.* When the plow is mounted on wheels it is called a *sulky-plow.* If two or more plows are attached together so that two or more furrow-slices are turned over at the same time we have a *gang-plow.* The gang-plow can be used successfully only in large fields. On some very large fields in prairie regions plowing is done with large gang-plows pulled by an engine. Sometimes two plows, a right and a left, are attached side by side to the same axle of a sulky, so that one plow is used to plow across the field in one direction and then, by turning around and going back in the furrow just made, the other plow is used. This is called a *reversible* plow. It is always mounted on wheels and is useful in plowing hillsides. Another kind of reversible plow has the share and mold-board so arranged that they can be turned under the shank,

and one can plow backward and forward along the side of the hill. This is called a *swivel-plow*. There is a kind of plow which has a concave disk in place of the share and mold-board. This is called a *disk-plow*. It does good work in stubble ground, free from sticks and stones. It has not come into use very much yet. A *subsoil* plow is one that can be run in the furrow made by the ordinary plow and stir up



5. A SUBSOIL PLOW

the subsoil. It has a longer shank than other plows and usually does not turn a furrow-slice, but shoves through the ground like a ground-mole, loosening the soil.

Plowing.—Plowing is the most important tillage operation. Its main purpose is to pulverize the soil. When the soil slips up over the mold-board the particles are made to slip over each other and so tear it apart, making it loose. When the ground is in just the right condition to plow, the furrow-slice will be turned over with scarcely any clods and a very small amount of harrowing will put the soil in good condition for seed.

Besides pulverizing the soil, the plow is useful for turning under trash, weeds and manure. The jointer aids in turning these under completely. It is desirable to have these turned under so that the surface will be free in order to plant the seed well. Furthermore, by decaying under ground, the material will be more useful as plant food.

Plowing may be done at any time of the year, except when the ground is frozen. In general, land is plowed in the spring or in the autumn. Where land is to be put in winter wheat it is plowed early in the autumn, say August and September. For corn and oats the land may be plowed in late autumn or in the spring. 1. By plowing in the autumn the soil is exposed to freezing and thawing weather which aids in breaking up the soil particles and makes more plant food ready for plants. 2. It also catches the rain and snow better and thus holds more moisture. If the land is well drained this is desirable, for such land fall-plowed will have more moisture for the plants next year than land plowed in the spring. 3. Land plowed in the autumn will dry off quicker next spring than unplowed land and so the crop can be put out sooner. 4. Plowing in the fall also turns up to the weather many insects that live in the ground during the winter. Many of them are picked up by the winter birds or are killed by the freezing and thawing weather. It is better to plow sandy soil in the autumn, if manure is to be turned under. Loam soils can be plowed to good advantage in the fall, but if a clay has a habit of running together when it thaws it would better not be plowed until spring. Land that has a tendency to wash should not be plowed in the autumn unless the furrows are thrown across the direction that the washing will take place. Hillsides are often plowed this way in the fall. Fall-plowed land

should not be harrowed down, for the freezing and thawing and rains will make it flat enough.

Spring plowing should be done as early as the land is dry enough. Care must be taken that the soil is not too wet or clods will be made, and the furrow-slice will become more compact than before plowing. When the soil is dry enough to crumble easily after being squeezed into a ball in the hand, it will crumble up nicely in the plowing. Early spring plowing is best because it keeps the moisture from drying out of the soil. We can think of the plowed ground as being a deep mulch, preventing the moisture in the subsoil from getting to the surface and evaporating. It is not a good plan in a dry spring to wait for rye or clover to get a good start before plowing under, because they will greatly reduce the soil moisture. Then, too, such a method may turn under so much material that the furrow-slice will be disconnected from the subsoil and the moisture from below will be hindered in passing upward into the furrow-slice. If there is a period of little rain after such plowing, the crops planted will suffer for moisture.

The purpose of subsoiling is to loosen the soil to a greater depth than the ordinary plow does. This enables the soil to receive and retain more water and also to let the roots feed deeper. Subsoiling should be done in the autumn or summer, because the ground is not dry enough in the spring. Subsoiling is hard work for the team and the plowman; it is seldom necessary in well drained land; and the results hardly ever pay for the extra labor, except with very hard subsoils.

In plowing, one of three kinds of furrows is generally turned. 1. The *flat furrow* is one in which the furrow-slice is completely turned over flat. It does not pulverize the soil

well and is hard to work up into good condition. 2. The *lap* or *overlapping furrow* is one in which the furrow-slice overlaps the previous one and covers about half of it. In this kind of furrow the slice seems to be standing on one corner. This is the kind of furrow that should be used in fall plowing,

6. A GOOD JOB OF PLOWING
A reversible plow is being used
By courtesy of the Indiana Experiment Station

for it will expose considerable surface to the weather and will catch much rain and snow. 3. The *rolling furrow* is much like the lap furrow except that one edge seems to be rolled under and the whole slice does not seem to be standing so much on a corner. The rolling furrow is made by a plow having a jointer attached. This kind of furrow-slice pulverizes the soil well and leaves the land in good condition to harrow.

Harrowing.—The purpose of harrowing is to put the ground in good condition to receive the seed. After the plowing has been done there are many small clods that can be easily broken if a harrow is dragged over the land. If the land plowed has been sod, it will be necessary to stir the plowed ground to break up the roots and make fine soil to cover the seed. Sometimes, also, after plowing there come heavy rains which beat down the land so hard that harrowing is necessary to loosen it. Besides putting the soil in shape to receive the seed, harrowing helps to warm the soil by loosening it so that the warm air can circulate through it. At the same time this loosening and fining the surface aids in keeping the moisture in the lower soil from being evaporated at the surface. Making the soil fine lets more plant food become available for the plants. So it can be seen that harrowing is also important.

There are several kinds of harrows and each has its particular usefulness. 1. The *spike-tooth* or *smoothing harrow* has a wooden or iron frame into which iron teeth are fixed. These teeth can be made to stand straight or to slant as desired by means of a lever. It is usually made in sections. This kind of harrow is most extensively used. It is good to break clods, loosen the soil when not too hard, and to level down uneven land. Its most important use is for pulverizing and levelling the surface soil. 2. The *spring-tooth harrow* has curved strips of steel fixed into a frame. These can be regulated by means of a lever also. This kind of harrow is useful mainly for loosening up ground that has become packed. It needs to be followed by a spike-tooth harrow to level down the little ridges left. 3. The *acme* or *colter* harrow is made of a number of sharp blades, like corn knives,

which drag over the land and cut and turn it a few inches deep. This kind of harrow is especially useful on sod ground, but is not extensively used. It cannot be used successfully on trashy or stony ground. 4. The *disk* harrow is made up of a number of disks fastened to a shaft which turns with the disks. These disks are about twelve inches or more in diameter, and cut the ground two to three or four inches deep, according to the angle at which they are set by the regulator.

7. A DISK HARROW AT WORK

The disk is useful to cut clods to pieces and to cut up ground that has become compact. It is also useful on sod ground to cut the sod to pieces and make loose soil. It is frequently used in the spring to cut up corn-stubble ground to prepare it for oats. The disk should be followed by the spike-tooth harrow to level down the ridges and crush the smaller clods.

Rolling.—Sometimes the land is so full of large, hard clods that the harrow will not put it into shape without a great deal of labor. The roller is then a useful tool to use. This is sometimes a tree cut into sections and fastened into a frame

and sometimes is made by bolting narrow planks on iron wheels. Another kind of roller, called a clod-crusher, is made entirely of cast-iron wheels. The roller is always a heavy tool and crushes the clods and at the same time packs the land. After the land is rolled it should be harrowed with a spike-harrow to loosen the surface and tear the crushed clods apart.

Frequently the land is too loose for the crop that is to be planted. The roller can then be used to pack the land. At other times the soil is quite dry when the seed is planted. Rolling will pack the soil about the seed so that the moisture will come in contact with it and help the germination. By packing the soil the capillary rise of moisture is increased and water is brought from below to the surface. Thus rolling in a dry time tends to make the soil wetter near the surface, but it should not be left smooth very long. It should be harrowed as soon as the planted seed has germinated to prevent the evaporation from the surface.

Disking.—We have just said that a disk harrow is a good tool to cut up the clods and to loosen a packed surface. Sometimes in the spring before the farmer can get all of his corn-stubble ground plowed, the surface has become quite hard and dry. When this is plowed with the ordinary plow the clods turned over will be big and it will take a good deal of work to make them fine. Even after a good deal of harrowing and rolling there will still be clods in the under part of the furrow-slice. These clods will interfere with the upward movement of moisture and will also keep the roots of plants from getting their food. The clods being hard the roots will not penetrate them freely, so the food that is in such clods cannot be easily obtained. It is a good practice for the farmer to disk his corn-stubble ground before he

plows it. Disking will keep the hard crust from forming and will also save the moisture by keeping it from evaporating. Land treated in this way will plow more easily and there will not be so many hard clods turned over. The work of preparing the plowed ground for seed will be less, for there are fewer clods and the furrow-slice will pulverize better in turning over.

If the field to be plowed was in clover last year so that there is a good deal of stubble left on the ground, it is a good plan to disk it before plowing. Besides preventing a crust, the disking will mix the stubble more or less with the soil. This is desirable because the stubble will rot more quickly, and because if the stubble were not mixed with the soil but simply turned under, it would tend to check the upward movement of capillary moisture and so hinder the growth of the plant's roots, especially if the weather is dry. For the same reason disking is good for land covered with manure. It is also good for sod land before plowing, but the cutting action of the disk is not so great on sod as on stubble.

Cultivation.—By cultivation we mean the stirring of the soil after the crop has been planted. Usually it is not done until the plants have come up and can be easily seen. Corn and potatoes are the main farm crops cultivated. Cultivation has two main objects. One is to kill weeds and the other is to save moisture. Usually it is not the purpose of cultivation to loosen the soil, although this is sometimes necessary after a packing rain. The plowing of the ground, if it was well done, did that. We need to kill the weeds because they use water and plant food and also choke out the young plants that we want to grow. It takes just as much food and water to grow a rag-weed as it does a corn plant of the same size. We need to save moisture, for during the summer we have

less rain than in the spring, and the ground soon gets too dry for the plants to grow well. When the plants get large they use a great deal of water and so draw much moisture from the ground. Professor King* tells us that when a corn plant is coming into tassel it uses nearly three pounds of water

8. THE ROOT SYSTEM OF A CORN PLANT

One of these large roots cut off in cultivating means much loss of moisture and food to the plant.

By courtesy of the Indiana Experiment Station

every day. If we think of all the stalks in the field using that much water daily we can see how important it is to save the moisture.

Cultivation saves moisture by making a loose, dry layer of soil on the surface. This dry layer acts like a blanket and when moisture comes up from below it can go no further

* *The Soil,* p. 208.

than the dry layer and so is not evaporated. It must be understood, however, that not every bit of moisture can be saved. Some of it finds its way through the dry layer and is lost. A dry layer two and one-half or three inches deep is best for saving the moisture. It is better not to stir the ground deeper than this, for by so doing the roots of the plant are likely to be disturbed.

When corn plants are eighteen inches high their roots reach clear across the middle between the rows, and some of the roots are not far from the surface. If one of these roots is cut off the plant has to do without the food and water which that root would have furnished. When we stir the ground two or three inches deep we are giving shallow cultivation. Deeper than three inches is generally called deep cultivation. It is better to have the surface left nearly level after cultivating than to have high ridges. If the cultivator has small teeth or shovels the ridges will not be very high. The high ridges give more surface for the evaporation of water, hence they are not desirable. It is not necessary for the ground between and around the plants to be ridged up to make the plants stand up well.

The number of times that a crop should be cultivated cannot be told exactly. It should be cultivated often enough to keep down the weeds and to keep the surface loose. Even if the weeds are all killed the ground should be stirred about once a week until the crop is well grown, for the loose surface will become more or less settled and more water will be evaporated. In other words, the soil mulch will wear out and must be renewed.

There are many kinds of cultivators, but to be effective they must all have two merits. They must be easily regulated

and they must stir all of the surface soil. There are harrow-tooth cultivators, spring-tooth cultivators, colter or shovel cultivators, gopher cultivators, and disk cultivators. Some cultivate only one side of a row at a time, most of them cultivate a whole row at a time, and some of them cultivate two rows at a time. But any and all of these cultivators must fulfil the two requirements if they are to do good work.

9. A TWO-ROW CORN CULTIVATOR

The most common cultivator is the *sulky cultivator*. In this the parts that do the cultivating are attached to a frame which is carried on wheels. It has two parts called gangs to which the shovels or disks are attached. It can cultivate one row at a time. There is usually a seat so that the workman can ride and guide the gangs. There is a sulky cultivator which has three gangs that can cultivate two rows at a time. It is called a *two-row* cultivator. It can be used conveniently only in large fields.

Fallowing.—This method of tillage is no longer used as it once was. In fallowing, the ground is plowed in the spring and kept harrowed and cultivated during the summer. No crop is planted. The harrowing and cultivating keep the weeds down and save the moisture in the soil. Sometimes the land is re-plowed two or three times during the summer. The purpose of fallowing is to rest the land and increase its fertility or to kill troublesome weeds. The land does not exactly rest, but since it does not produce any crop there is no draft upon its store of plant food and the plowing and cultivating of the land loosen it so that the air and water and bacteria can get at the soil particles and make more plant food ready for use next year. The growing of the same crop year after year on the same land caused it to run down and made the need for rest. We now know that it is better to change the crops on the field every year, that is, practice a rotation. We shall tell all about rotations in another chapter.

CHAPTER VI

FARM MANURES

FARM manures are of two kinds: 1. Farmyard manure, obtained from stables and yards. 2. Green manure, obtained by plowing under green growth of rye, clover, cowpeas, or even weeds.

The value of farmyard manure is influenced by three things: 1. Its source. 2. The manner of saving. 3. The time and way it is applied to the land.

1. **The Source of the Manure.**—(*a*) The droppings from such animals as horses, sheep and chickens are rather dry, and when thrown in a pile soon get quite warm and "heat," as we say. They are called "hot" manures. The droppings from cattle and swine are quite wet and do not heat so quickly when thrown in a pile, and are called "cold" manures.

(*b*) The manure from young and growing animals, as colts and calves, is not so valuable as that from older animals, and especially animals that are fattening. The excrement generally contains 70 to 95 per cent. or more of the elements that were in the food eaten by the animals. Now, young and growing animals use up more of the nitrogen, phosphoric acid, and potash in the food for their bodies to make blood, bone, and flesh than do older animals.

(*c*) The manure from animals that are fed on rich food, like clover, alfalfa, bran, cottonseed-meal, oats or other foods rich in nitrogen, is better than that from animals fed on tim-

othy hay, straw, corn stover or other feeds not rich in nitrogen and to which little or no grain has been added.

(*d*) Animals poor in flesh do not make valuable manure, because they remove much of the plant food that is in the food to build up their own bodies. The making of bone and lean meat and blood requires much nitrogen, phosphoric acid and potash, but the making of fat does not require very much of any of these elements.

(*e*) The bedding used in the stable should be a kind that will absorb the liquid excrement readily. The liquid excrement contains a large per cent. of the nitrogen and potash that was in the feed. These are valuable plant foods and should be saved. Straw is the most common bedding used and absorbs liquids fairly well. Shredded corn stover that has been left uneaten by the animals makes an excellent bedding. It absorbs better than straw. Sawdust is a good absorbent, but it is injurious to the land and should not be used for bedding.

2. **Saving the Manure.**—The manure on most farms is not saved carefully. Often animals are confined in yards and no effort at all is made to save the droppings, and the rains wash them away, or they are tramped into the mud. Very often when stables are cleaned out the manure is thrown under the eaves of the barn or shed and the rain from the roof soon saturates the pile and a dark liquid soon begins to run away from it. This contains much plant food in the form of nitrogen and potash and is usually lost by draining into a stream or soaking into the ground where no crop is raised. Then again, it often happens that manure is thrown into large piles or boxes where it lies exposed to rain and weather for several months. Under such conditions it gets

warm, "heats," and ferments. This fermenting causes the production of ammonia which contains nitrogen. This escapes into the air and is lost. All of these ways are more or less careless, and on nearly every farm better methods could be used. It is better to allow the manure to accumulate in the stable and be trampled under foot by the animals, providing plenty of bedding is given, than to throw it out in a pile to ferment and burn. The tramping in the stable keeps the manure solid and thus keeps it moist and from heating. In some cases, for instance, where calves, colts, sheep, or steers are fed loose in a stable or shed the manure might be allowed to collect during the entire winter. As soon as the animals are taken out of the stable or shed the manure should be hauled to the field and scattered at once. Or, if the stable is cleaned out during the winter, the manure should be taken to the field at once. Where animals are kept in open yards the droppings should be gathered every day and thrown into a pile which should be hauled out every few days. Sometimes the ground is too wet to drive over, or the field on which the manure is to be spread is in a crop. In such cases it may be desirable to keep the manure for several weeks. It should then be stored in a heap where it will not get wet enough to produce drainage, but where, if necessary, water can be applied to keep it from getting hot. The pile should be made solid and as deep as possible. A basin-like place with the bottom and sides cemented is a good place to store manure, and if it has a roof over it all the better.

It should be remembered that if manure must be kept in a heap for a time, the pile should be deep, solid, and wet, but not wet enough for drainage. It has been found by experiment that where manure was exposed in loose, shallow piles

it lost in less than four months more than half of its nitrogen, phosphoric acid, and potash. The potash and phosphoric acid got away by drainage and the nitrogen largely by fermentation.

3. **How to Apply Manure.**—We have said that manure should be hauled to the field as soon as possible. It should also be spread at once. It is very wasteful to dump the

10. USING A MANURE SPREADER
Spread in this way manure gives best results

manure off in piles and let it lie there for weeks before spreading. Every rain that comes will wash out some soluble material into the soil just around and under the pile. Thus it is that the plant food is not equally distributed over the field. Spreading the manure with a *manure spreader* is the very best way to get it distributed equally over the field. The manure spreader is a wagon whose floor is loose and is moved toward the rear end of the wagon by means of cogs. At the back end of the box is a spiked reel which also turns

by cogs. As the team moves forward the floor moves backward and the reel whirls around rapidly, catching the manure, tearing it apart and spreading it over the land much more completely, much quicker and easier than a man can do it with a fork.

It does not matter about plowing the manure under right away. What is washed out by rains will go into the soil and be soon used by plants. The only danger is when the land is sloping, causing the water to run away instead of soaking into the ground. However, when the manure is plowed under it will begin to decay and thus add humus to the soil and also give more plant food to the plants. It will also aid in holding water and in making the ground looser by keeping it from packing down so completely. When manure is spread, during the winter, on land that is to be plowed in the spring, it keeps the land from thawing and drying quickly in the spring. Especially is this true if it has been spread on top of snow. This, however, is not likely to result in any inconvenience except on undrained land.

It is better to apply small quantities of manure to the land often rather than large quantities not so often. For example, it is better to apply five tons per acre every three or four years than to apply ten tons every eight or ten years. With a manure spreader a small quantity of manure can be made to cover a larger area of ground and thus the fields can be treated oftener. The amount of manure applied per acre varies a great deal. Five tons is considered a light dressing, while twenty and thirty tons per acre are often applied, especially in gardening. Ten tons per acre is a very good amount for ordinary farm practice.

One good thing about farmyard manure is the way it lasts

in the ground. The effect of manuring can be seen on the yields of crops for many years after the manure has been applied. At the Indiana Experiment Station it has been shown that the manure was making an increased yield twenty years after it was applied.

Green Manuring.—By *green manuring* is meant the plowing under of green plants so that in their decay under ground they will add humus to the soil. Furthermore, the acids produced by their decay attack the rock particles and make new compounds, some of which are useful as food for plants. The addition of humus, as we have learned, aids the soil in retaining moisture in a better way and at the same time puts the soil into better condition for cultivation. Sandy soils are made cooler and clay soils warmer by the addition of humus.

Any kind of plant can be used for a green manuring crop. It is better to plow under weeds while they are green than to let them go to seed. Rye is a common green manuring crop. It is sown in the autumn and plowed under in the spring. The best green manuring plants are the legumes, because they add nitrogen, and nitrogen is the thing that most soils need. Clovers, cow-peas, soy beans and vetches are all good. Clovers do the soil most good if turned under in full blossom, the others when the pods are about one-half grown. Legumes are called nitrogen-gatherers, because they increase the total amount of nitrogen in the soil. All other plants used as green manures can give the soil only the nitrogen which they have obtained from the soil in the first place.

Usually it is better to cut the clover or cow-peas for hay and feed them and return the manure to the land. By so doing the farmer gets the benefit of the feed for his animals and nearly all the plant food goes back to the land to make it richer.

CHAPTER VII

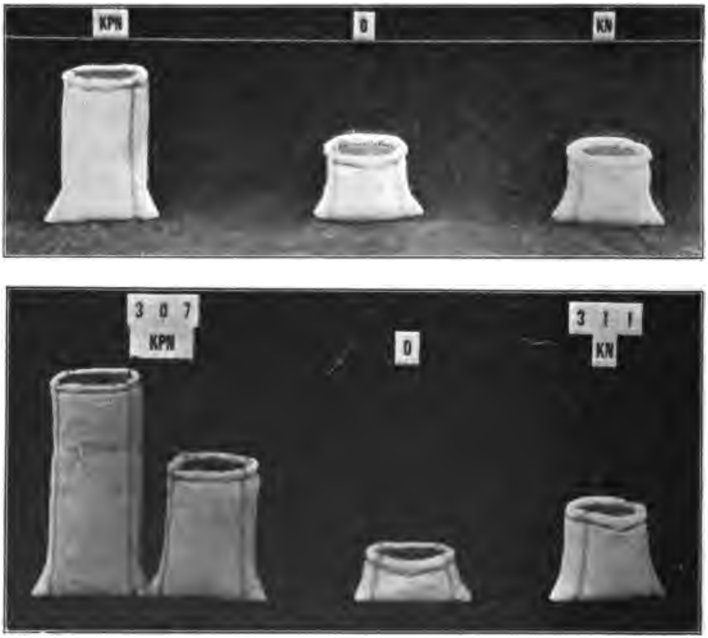
COMMERCIAL FERTILIZERS

A commercial fertilizer is a manufactured plant food. It is usually kept for sale at the warehouses and seed stores. Commercial fertilizers are used when the soil is lacking in some of the important plant food elements, or when the farmer wishes to give his plants an extra good start in order to produce larger crops. Gardeners frequently use commercial fertilizers in place of stable manure, because the stable manure contains so many weed seeds that it makes land weedy. Fertilizers do not contain any weed seeds.

There are many kinds of fertilizers, but they nearly all belong to one of three classes, namely, those which furnish nitrogen, phosphoric acid, or potash. Some fertilizers supply more or less of all three of these elements, but usually some one element is largest in amount. When a substance or mixture supplies all three plant food elements it is said to be a *complete* fertilizer. We can speak of only a few of the more common fertilizing materials.

The nitrogen fertilizers come from two sources, namely, from plant or animal sources, that is, organic materials, and from chemical sources. 1. Dried blood comes from the large slaughtering houses. The fresh blood from the animals killed is collected and dried. The best grades of dried blood contain 12 to 14 per cent. of nitrogen. Dried blood decays rather

quickly in the soil, and yields its nitrogen for the use of plants. 2. Tankage also comes from the slaughtering houses in large cities. It is made from the intestines and their contents, small bones, waste flesh, and other parts of the slaugh-



11. RESULT OF USING FERTILIZERS ON WHEAT

KPN stands for potash, phosphorus, and nitrogen. O stands for no fertilizer. KN stands for potash and nitrogen. Notice which element was most helpful in these cases. *By courtesy of the Indiana Experiment Station*

tered animal that cannot be used otherwise. This material is heated by steam and, when dry, ground into meal. Tankage usually contains some phosphoric acid as well as nitrogen. There are two principal kinds of tankage: (1) Concentrated tankage, containing 10 to 12 per cent. of nitrogen and very

little phosphoric acid. (2) Crushed tankage, containing 4 to 9 per cent. of nitrogen and 3 to 12 per cent. of phosphoric acid. There is a kind of tankage called *digester* tankage which can be used for feeding animals as well as for fertilizer. When buying it one should state for which purpose it is to be used, because that for fertilizer purposes only may contain chemicals that would be injurious to animals. Tankage also decays rather quickly. 3. Dried ground fish or fish guano, is made from a kind of fish called *menhaden,* caught along the Atlantic coast. The fish are steamed and pressed to get out the oil. The pomace is then ground and made into fertilizer which contains about 6 to 8 per cent. each of nitrogen and phosphoric acid. Some of the fish fertilizer comes from the wastes of fish markets and fish canneries. The nitrogen and phosphoric acid in these is quite variable. Fish fertilizers give up their plant food about as easily as tankage and dried blood. 4. Cottonseed-meal is usually used as a cattle food, but it can be used as a fertilizer as well. It is made from cotton seeds. The covering of the kernel is first taken off, then the kernel is ground and pressed to get out the oil. The pomace is called cottonseed-meal. It contains 6 to 7 per cent. of nitrogen and 1 to 2 per cent. of phosphoric acid. It makes a good fertilizer and is quickly available. When we say that a fertilizer is quickly available, we mean that it soon decays in the ground and gives up its plant food to the roots of plants. 5. Guanos are composed mainly of the excrements of fish-eating birds. Where large numbers of sea birds roost on the islands in rainless regions their droppings soon accumulate in large quantities. These are collected and shipped to farming regions. Most of the guano comes from islands lying off the coast of Peru, and is called Peruvian guano.

The supply from this source is now about exhausted. 6. Raw and steamed bone, meat meal, hoof meal, horn meal, wool and hair waste, leather waste, castor pomace, linseed meal, garbage tankage, and many other materials furnish nitrogen from organic sources.

The chemical nitrogen fertilizers are largely used. 1. Sulphate of ammonia is a by-product in the manufacture of coke, illuminating gas and bone-black. It contains about 20 per cent. of nitrogen and is quickly available. It should not be used on "sour" land, because it requires the bacteria of the soil to make it available. 2. Nitrate of soda is obtained in Chili, South America. There is a large rainless region there where this mineral is mined by the thousands of tons and shipped to all parts of the world. It is called "Chili saltpetre," and contains about 16 per cent. of nitrogen. The nitrogen in nitrate of soda is quickly available and is easily lost on sandy land by drainage. 3. Nitrate of potash, or common saltpetre, is too costly to be used by farmers for a fertilizer. It contains both nitrogen and potash.

The phosphoric acid fertilizers are also obtained from two sources, namely, from organic materials and from chemical materials. 1. Ground bone, or raw bone meal, is made from raw bones ground into meal, the finer the better. This contains about 4 per cent. of nitrogen and 22 per cent. of phosphoric acid. They are slowly available and their effect in the ground lasts for several years. Steamed bone differs from ground bone in that it has been thoroughly steamed before it was ground. The steaming takes out the fat and almost all the nitrogen. The per cent. of phosphoric acid is about 28 to 30, and the nitrogen about 1½. Steamed bone also becomes useful slowly. 3. There are other forms of bones called ex-

tracted bone, bone ashes, and bone-black, which are used to a small extent as fertilizers.

The phosphoric acid obtained from chemical sources is generally in the form called phosphate. There are two kinds of phosphates, the natural mineral phosphates and the manufactured phosphates. 1. Rock phosphate is a natural form. It is thought to be the fossilized excrement and remains of fish-eating animals which lived ages ago. These fossil deposits are found in South Carolina, Florida, and Tennessee. The rock is dug out and ground very fine and then it is ready to apply to the land. Rock phosphate is quite variable in its content. The South Carolina rock contains about 26 per cent., the best grades of Florida rock about 40 per cent., and the Tennessee rock from 30 to 32 per cent. of phosphoric acid. The rock phosphate is very slowly available. 2. Basic or phosphoric slag, also called Thomas slag, is a by-product in the making of certain kinds of steel. It comes in the form of a fine powder and contains 1·5 to 20 per cent. of phosphoric acid. There is also a good deal of lime and oxide of iron mixed with it. 3. The manufactured phosphate is frequently called a super-phosphate. A *super-phosphate* is a phosphoric acid fertilizer in which the phosphoric acid is quickly available. Super-phosphates are made by treating ground bone or ground rock phosphate with sulphuric acid. Such treatment dissolves the original material and makes new combinations which are more easily dissolved in the soil. (1) Dissolved bone is ground bone treated with sulphuric acid and contains about 2 per cent. nitrogen and 13 per cent. of phosphoric acid. (2) Acid phosphate, or dissolved rock, is made by treating ground rock phosphate with sulphuric acid. The amount of phosphoric acid in the acid phosphate

will depend upon the amount in the rock used. Acid phosphate is very extensively used.

The potash fertilizers are also from organic and chemical sources. 1. The chief organic source is ashes, wood ashes being the common source. The amount of potash in wood ashes differs with the kind of wood from which the ashes are obtained, as, for example, the unleached ashes from oak contain about 10 per cent. of potash, from beech 16 per cent., from elm 24 per cent. Hard wood contains more potash than soft wood. Ashes also contain large quantities of lime and small quantities of phosphoric acid, magnesia, and soda. Unleached ashes are the only kind that should be used as a fertilizer. By *leached* ashes we mean ashes that have been so soaked by water that the potash has dissolved and run away. 2. Tobacco stems contain from 6 to 10 per cent. potash, and are much used for mixed fertilizers.

The chief chemical source of potash is the German potash mines in Germany. At Stassfurt in Germany there are large deposits of salts which are rich in potash. 1. Kainit is the name of one of these salts which is sold on the market without having been treated in any way except grinding. It contains about 12 to 13 per cent. of potash. It has considerable magnesia and common salt mixed with it. Kainit is rather quickly available when applied to the land. 2. Muriate of potash is the name given to a potash fertilizer made from certain kinds of the German salts by a process called recrystallization. It contains about 50 per cent. of actual potash and is considered the cheapest source of potash for fertilizing. It is very extensively used. 3. Sulphate of potash is another potash fertilizer made from the German salts, by the process of recrystallization in which those crystals con-

taining mostly sulphate of potash are separated out. There are two grades: the high grade sulphate of potash contains 51 to 53 per cent. of potash, and the low grade about 26 per cent.

Besides the nitrogen, phosphoric acid and potash fertilizers, there are other materials which are frequently applied to the land, sometimes to add an element of plant food to the soil, but more often for the effect which they will have upon the soil in improving its texture. Such fertilizers are called *indirect* fertilizers. Lime is often put on land because the soil is lacking in lime, but more often because the land is "sour," and the lime will sweeten it. Lime also makes compact soils more crumbly, hence more easily worked. Leached ashes and coal ashes add nothing in the way of plant food, but the leached ashes will furnish a good deal of lime. Common salt is sometimes applied to land, especially sandy soil. It helps the soil to hold moisture and also aids somewhat in making lime and potash available. Large quantities will injure the plants. Land plaster or gypsum is also often applied for the lime which it contains. Where it can easily be obtained marl is used for supplying lime. It is especially good for sandy lands, because there is often a good deal of clay mixed with the marl which tends to make the sand more compact. Fine ground limestone is one of the best indirect fertilizers. It will sweeten sour land as quickly as lime and will not burn out the organic matter as lime does. Ground limestone should be applied at the rate of two tons or more per acre. Usually autumn is the best time to apply it.

The best way to find out what elements of plant food are needed in the soil is by actual experiment on land. A small area which represents the whole field fairly well is laid out

in plots and each fertilized differently. When the crop is harvested and weighed and the results compared, one can tell which fertilizer did the most good.

Ordinarily fertilizers are applied from a box fitted to the machine which plants or sows the seed. In the case of wheat and oats the drill usually has a box into which fertilizer can

12. APPLYING LIME TO LAND WITH A SPECIAL MACHINE
By courtesy of the Ohio Experiment Station

be put and sown at the same time as the grain. Many corn planters have fertilizer attachments which scatter the fertilizer in the row. For some garden and truck crops it is desirable to put the fertilizer in the hill or the row where the roots can easily get the plant food. Care must be used in such cases, for the dissolved fertilizer may be so strong as to kill the roots of the plants.

Stable manures, clover, and a good rotation of crops should

always be used in connection with commercial fertilizers. By so doing the humus in the soil will be maintained and the fertilizers will be more effective. If fertilizers are used alone, the humus becomes exhausted, the soil becomes hard and compact, and the fertilizers fail to give the desired results.

SECTION II—FARM CROPS

CHAPTER VIII

CLASSIFICATION OF FARM CROPS

Before we begin to study about the different crops that farmers raise, it will be well for us to classify them into a few groups by which they are commonly mentioned.

1. **Cereals.**—By *cereals* is meant those crops which belong to the grass family and whose seeds are made into flour which is used for bread. The principal cereal crops are corn, wheat, oats, rye, barley, rice, and millet. Rice and millet are scarcely ever used for bread in this country, but in India and China they are used extensively.

2. **Legumes.**—We are all familiar with the appearance of the blossoms of the garden pea and of sweet peas. There are many plants which have similar blossoms. All such plants are called *legumes*. Some of the common legumes are alfalfa, all of the clovers, cow-peas, soy beans, peas, beans, and vetches. Legumes are desirable plants for the farmer to raise because they have nodules on the roots in which live bacteria that collect nitrogen from the air. Some of this nitrogen is stored in the leaves and stems of the plants and some remains in the nodules on the roots. When the plant is used for feed it makes a richer food than such plants as timothy or blue grass. Also, when the plant dies the roots remaining in the ground contain more nitrogen than the roots of other

plants. This makes the soil richer in nitrogen and so better for the crop that follows. Nearly all legumes have a strong main root, called a *tap* root, which grows deep into the ground. When they die the tap roots have a tendency to leave the soil looser than do the roots of plants which are smaller.

3. **Roots.**—Certain crops like beets, turnips, carrots, parsnips, and radishes are called root crops. When quite young these plants have a long, slender tap root which gets larger as the plant gets older. It is the enlarged tap roots then which form the root crop. These tap roots, however, do not have nodules on them like the legumes and so do not gather nitrogen. Root crops are used for feed for live stock, and nearly all kinds may also be used for human food.

4. **Tubers.**—A tuber is an enlarged underground stem. If we examine a potato plant carefully we shall find that the stem above the ground continues underground as a somewhat smaller white root-like stem. At the end of this root-like stem will be found an enlargement, the potato or *tuber*. The same examination will show that the real roots start from the base of the above-ground stem and are quite different from the underground stem. Irish potatoes, sweet potatoes and artichokes are examples of tubers.

5. **Bulbs.**—Doubtless we all know enough about botany to know that a leaf is made up of two parts: the expanded part, or *blade*, and the stem, or *petiole*, which connects the blade to the stem of the plant. This petiole is quite easily made out in the leaves of trees, but in such plants as onions and tulips it is not so easily seen. That which we call the onion is nothing but the enlarged and thickened petioles of the onion leaves. The blades of the leaves in the case of the onion are curiously changed. So we say that a *bulb* is the en-

larged and thickened petioles of the leaves. The onion is our only bulb farm crop, but tulips and hyacinths are other examples of bulbs.

6. **Fibre Crops.**—Any plant that furnishes material out of which cloth or rope is made is called a *fibre* plant. Cotton, flax, and hemp are common crops in the United States from which fibres are obtained to make cloth, twine, and ropes. Jute, sisal, and manila hemp are obtained from plants grown mostly in other countries.

7. **Forage Crops.**—The term *forage* crop is used for a good many crops. It means one that is used for coarse feed like hay, fodder, stover, straw, silage, or pasture. Crops that are employed for other purposes may also be used as forage crops. For example, wheat is raised principally for its grain, but it may be cut green and made into hay and thus become a forage crop. Forage crops will be more fully explained in another chapter.

8. **Miscellaneous Crops.**—There are many other crops that are raised on the farm that we cannot so easily classify. Some of them are: tobacco, broom corn, hops, mint, tomatoes, etc. These have to be considered separately.

CHAPTER IX

CORN

In the next few chapters we shall study about some of the principal crops grown for their seeds. Some of them are used for other purposes besides seed production, but these will be spoken of later. We shall speak briefly of the history, culture, and uses of the various crops. Before beginning we need to explain that by *culture* we mean the soil to which a crop is adapted, and the way of planting, cultivating and caring for the crop.

Maize or Indian Corn.—The plant that we call corn is strictly an American plant. It is the only cereal that the New World has given to civilization. Corn has not been found growing wild, but a great deal of evidence goes to show that its native home was in Mexico and Central America. When the early settlers came to America they found the Indians raising corn. The settlers soon learned its usefulness, and finding how easy it was to raise, they soon grew it wherever they went. To-day it is grown in every state of the Union. The corn crop is four times as large in number of bushels as that of any other grain crop in the United States. Iowa, Illinois, Missouri, Kansas, Nebraska, Indiana and Ohio produce more than half of the corn raised in the United States. These states form the so-called "corn belt."

Kinds of Corn.—There are six kinds of corn, namely: dent, flint, sweet, pop, pod, and soft corn. More care has been

given to the cultivation of the first four than to the last two. The number of varieties of each is very great.

Dent corn is the kind raised in all the principal corn-growing states. It has a rather long kernel which has a dent in the top. This dent is caused by the shrinking of the kernel at the centre more than elsewhere when it begins to get ripe. Dent corn produces the largest ears of any kind of corn. The

13. PUTTING IN SHOCK IS A GOOD WAY TO SAVE THE CORN FODDER UNTIL IT IS READY TO BE SHREDDED

By courtesy of the Indiana Experiment Station

varieties have variously colored kernels. Three hundred and twenty-three varieties have been described.

Flint corn has a short and rounded kernel which is quite hard. It has no dent in the top. An ear of flint corn is quite smooth and does not have so many rows of kernels as an ear of dent corn. Flint corn does not take so long to mature and so is raised in our most northern states and in Canada. The stalks and ears do not get so large as those of dent corn.

Sweet corn usually has a shrivelled kernel which is sweet to the taste. Sweet corn is raised by farmers and truck gardeners largely for table use and for canning purposes. Farmers

rarely raise it for the purpose of feeding the grain to cattle and hogs. Sweet corn has a larger per cent. of protein and fat than other kinds of corn. There are sixty-three or more varieties.

Pop-corn is raised almost entirely for selling to persons who make cracker-jack and pop-corn. Neither the ears nor the stalks grow very large. The kernels are always quite hard and flinty. The bursting open when popped is said to be due to the explosion of the moisture in the seed when heated. Some varieties of pop-corn have quite sharp-pointed kernels; these are called the *rice* varieties. Others have quite smooth and blunt-pointed kernels; these are called *flint or pearl* varieties. There are twenty-five or more varieties.

Pod corn has each kernel enclosed in a chaff somewhat like a kernel of wheat, so that when the husk is removed from the ear the kernels are still covered. Pod corn is raised only as a curiosity.

Soft corn has kernels resembling the flint kernels, but they are not nearly so hard. The kernels are soft and floury inside. Soft corn is raised somewhat in the south-western states and in Mexico. Brazilian flour-corn is a soft corn.

The size of the ear and stalk of corn is quite variable, depending upon variety and climate. Dr. Sturtevant * speaks of a variety in which the stalks grow only about 18 inches tall, while in the West Indies stalks sometimes grow as high as 30 feet. He also speaks of having seen ears of pop-corn only an inch long and ears of dent corn sixteen inches long. The flint varieties usually have eight or twelve rows of kernels to an ear; the dent varieties usually have from sixteen to twenty-

* See 15th Biennial Report of Kansas State Board of Agriculture, p. 14.

four rows. Dr. Sturtevant also speaks of a variety which matures in one month in Paraguay, while seven months are required in some southern countries. The stalks and ears of varieties raised in North Dakota and other northern states are much smaller than those of varieties raised in the corn belt states.

Soil for Corn.—Corn will grow in almost any soil that is not too wet or too dry. It grows best, however, in a well-drained loam soil rich in organic matter. Muck soils are apt to be lacking in potash and have too much nitrogen to produce good solid corn. Sandy soils are likely to get too dry in July and August for corn to grow well. Heavy clay soils are too compact unless they are well drained and plenty of coarse manure is used.

Plowing and Preparing.—Land for corn may be plowed in autumn or spring. If autumn plowed the supply of moisture is apt to be better the following season. Spring plowing should be done as early as possible in order to save moisture and prevent the formation of a crust which will turn under cloddy. The plowing should be well done so that the furrow-slice is well pulverized. The land should then be thoroughly harrowed with a spike-tooth harrow to level it and pulverize the clods. If autumn plowed, the land will usually need to be disked before harrowing. It can sometimes be worked up by using a spring-tooth harrow. If land is too cloddy it should be rolled or dragged. Dragging is better, if it will crush the clods, because the drag does not pack the ground so much as a roller. In either case the land should be harrowed again soon to loosen the surface and prevent evaporation. It is desirable to have the field dragged just before planting, for then the planter can be driven straighter with more ease. It will also do no harm to harrow just after planting.

Planting.—When the seed bed is in good condition and the soil is warm enough the corn should be planted. Corn is a warm weather crop, so that generally it pays to wait until the top soil has warmed up. It is usually planted in May in the corn belt states. The two-horse check-row planter is now used almost entirely by farmers. Only very small fields are planted by hand. Corn is planted either in hills or in drills. There is really no difference as to the amount of corn that can be raised by the two methods. The corn in drills is not so easy to keep free from weeds, for such corn has to be cultivated in one direction all the time and the weeds get a start in the row unless the early cultivation has been carefully done. It is desirable to have two to three kernels of corn dropped in each hill when hilling it, or a kernel about every sixteen inches when drilling it. The seed should usually be covered about one-and-a-half to two inches deep. In the drier regions of the west and sometimes on sandy ground corn is *listed*, that is, it is planted in a furrow, four or five inches below the level of the ground. A machine called a lister, throws open a furrow, and drops and covers the corn in the bottom of it. Listing is not desirable where there is a heavy rainfall.

Cultivation.—If necessary, the cultivation of corn can begin before it is very large, even before the young plants are out of the ground. If, by reason of wet weather, the weeds get a start, the field may be harrowed with a spike-tooth harrow, or by following the rows made by the planter wheels, a sulky corn cultivator may be used. Usually, however, cultivation does not begin until the young corn plants are three or four inches high, and, if the seed bed has been well prepared, it will usually not be necessary to commence sooner.

Corn should be cultivated often enough to keep down weeds

and to save the moisture. The soil should be stirred after every rain as soon as it is dry enough to work, for only by keeping the top two or three inches loosened from the under soil can the loss of moisture be prevented. Even if no rain falls and the weeds are all killed, the soil needs to be stirred about every week or ten days, for the soil mulch will lose its effectiveness. Cultivation should be kept up until the plants begin to tassel out. By this time the plants will be too large

14. A HARROW TOOTH CULTIVATOR
A good tool for preserving a soil mulch in tall corn
By courtesy of the Indiana Experiment Station

to pass under the arch of the cultivator without breaking off. Further cultivation can be given with a single horse and cultivator. However, this is scarcely ever done.

The cultivation should be about two to three inches deep. This depth has been found better for saving moisture than a lesser depth. If the ground is stirred deeper than three inches there is danger of disturbing the roots. When corn is about a foot and a half high the roots extend entirely across the middle from one row to the other, and deep cultivation will break these off and thus check the growth of the plants. In

cultivating, the surface should be left as level as possible so that there is no increased opportunity for evaporation.

Harvesting.—The feeding value of the stalk and the grain is greatest when the lower leaves of the stalk have begun to ripen and when the kernels of the ears are glazed over and have begun to dent and the husks are drying up. If corn is either to be shocked or put into the silo, the cutting should be done at this time. By far the largest part of the corn crop is allowed to ripen on the stalk, but by so doing about half of the feeding value of the stalks is lost. Cutting the corn insures a more profitable use of the entire plant. Formerly corn was cut entirely by hand and put into shocks, but now many farmers have corn binders, some of which both cut and shock the corn. Shocks should be made large, so that there will be as little fodder exposed to the weather as possible. However, they must not be so large that they will not dry out well. Shocks containing one hundred to one hundred and twenty hills are about the right size to dry out properly.

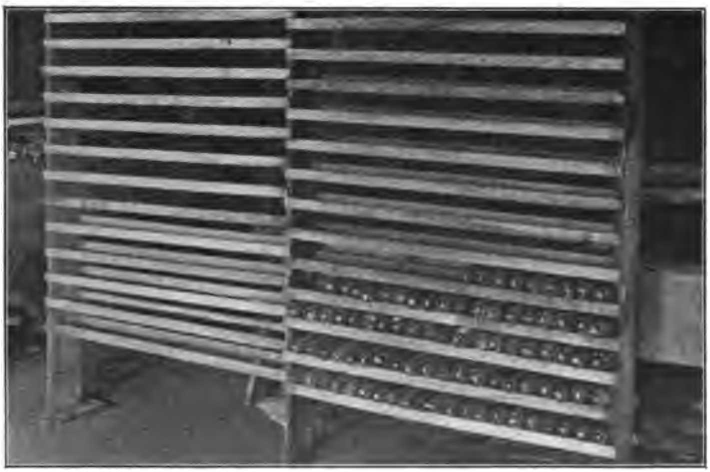
Before going further we must explain two words. The word "fodder" means the entire plant before the ears are husked. The word "stover" is applied to the stalk after the corn is husked. Formerly the husking was all done by hand, but now much of it is done by machinery. When the corn is dry enough to husk, and this is when the grains will shell off the cob, the fodder is run through a machine which snaps off the ears, pulls off the husks, and at the same time, tears up the stover into shreds. The ears run out of a chute into a wagon-box. This is called *husking* and *shredding*. The shredded stover is blown into a mow where it is convenient for feeding. The ears are usually put into a crib or hauled to market, or they may be used for feeding at once.

When the fodder is left standing in the field the ears are husked by hand as soon as dry enough, and then the stover is pastured off by live stock. A machine is being perfected now which husks the corn from the standing stalks and elevates the ears into the wagon box. It works very much like the corn binder.

Saving Seed.—About the time the husks are beginning to dry the farmer should gather ears for seed for next year. He should take a sack or basket and go through the field, picking such ears as look to be good seed ears. Ears should be chosen from stalks of medium height which are strong at the base and taper toward the top and which stand up well. The ear should be growing about midway on the stalk, high enough to be easily husked. Ears whose tips are pointing down should be chosen rather than those whose tips point upward.

After being gathered the ears should be hung up in a shaded place where the air has free movement. Many farmers collect the ears with some of the husks on and then tie two ears together by the husks and hang them over a pole, or on a nail driven in a rafter in the wood shed or tool house or corn crib. (See Fig. 15.) The ears are allowed to dry here until cold weather, then removed to a dry place where they will not freeze. Corn saved in this way will be sure to grow next spring and the farmer will have no trouble in getting a good stand of plants.

Testing.—When seed corn is selected at husking time care cannot be given to the kind of stalk on which the ear grew. The vitality of the seed may also have been injured by frosts and freezing weather. Such corn should be tested before planting in the spring. Corn is tested by planting several



15. TWO GOOD WAYS TO DRY SEED CORN

The upper picture shows the seed ears hung to rafters of the tool shed; the lower picture shows racks made of lath and six-inch boards. Every farmer can use one or the other of these schemes.

By courtesy of the Indiana Experiment Station

kernels, usually five, from each ear in a box in a moderately warm room. If four out of five kernels grow the ear is fit for seed, but it is better to have every kernel grow. There are many ways of testing the kernels, but the use of a box like that in Fig. 16 is good. The box is about 18 inches wide, 24 inches long and 2 inches deep and filled with garden soil

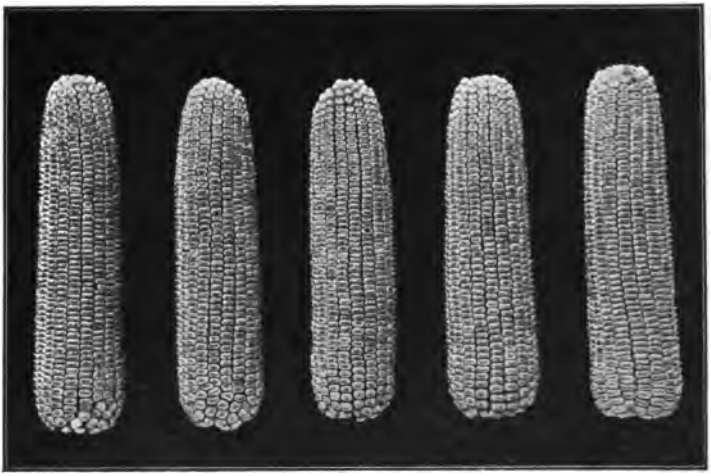
16. TESTING VITALITY OF CORN—THIS IS ONE OF THE GOOD METHODS
By courtesy of the Indiana Experiment Station

over which is a half-inch of clean sand. The top is divided into one and a half inch squares by means of wire. The five kernels from each ear are placed in a square. The ears may be tagged to correspond with the squares or be laid in regular order on a rack. When the squares are filled the kernels are pressed into the soil and the soil dampened. The box is now covered with glass or loosely woven cloth and put into a room having a temperature of about 70° F. In five days all the

kernels should be sprouted. (It may be necessary to wet the soil again during this time.) In examining the kernels care should be taken to notice whether or not both the stalk end and the root end of the germ have grown. Sometimes only one end grows. Such kernels should be discarded. Since one ordinary sized ear will plant one-fourteenth of an acre, the importance of having every ear a good one is easily seen.

Choosing the Seed Ears.—The details for choosing the seed ears cannot all be given here. In the first place an ear of medium size should be chosen, the rows should be straight, and the ear should taper but very little from the butt to the tip. The kernels should keep their size out to the end of the tip, and there should be as many rows at the tip as there are at the butt. There should be but few irregularly shaped kernels at the butt or tip. The kernels should round out well over the cob at the butt and should come as near covering the cob at the tip as possible. However, it is better to have a little of the cob exposed at the tip than to have it covered with a large number of small, flinty kernels. The kernels should fit up tightly together at the cob, and there should be very little space between the rows on the outside. The kernels should not be sharply rough, neither should they be smooth. They should be longer than wide and taper just a little from the *crown* to the tip. When removed from the cob the tip of a kernel should not break off showing a black end. Such kernels are not well matured. The back of the kernel should be clear and flinty looking. The color should be uniform whether it be yellow, white, red or speckled. Kernels of any other color or different shades of the same color show mixture.

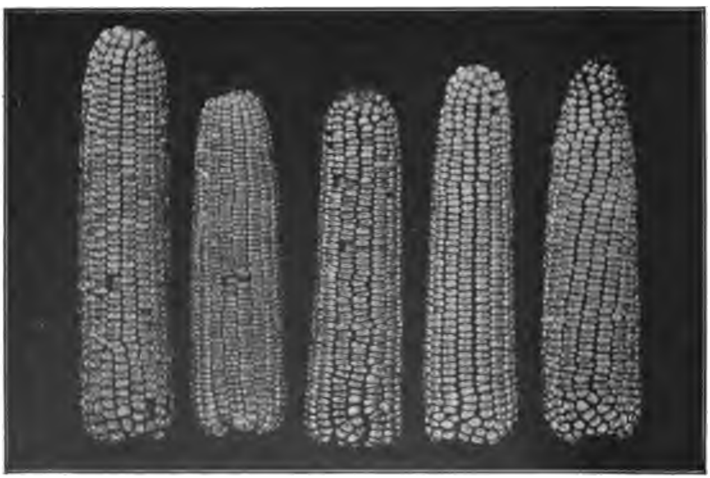
Preparing for the Planter.—After selecting and testing, the ears are ready to be shelled. The shelling should not be



17. GOOD SEED EARS

Notice the cylindrical shape, straight rows, uniform kernels, and well-formed butts and tips.

By courtesy of the Indiana Experiment Station



18. POOR SEED EARS

Notice that these ears show characteristics just opposite to those in the cut above

By courtesy of the Indiana Experiment Station

done, however, very long before planting, for if put into large bags the kernels may "heat" and spoil the vitality. The tips and butts are shelled off and not planted because the planter will not plant them accurately, and usually the tips will not grow so well as the middle kernels. In shelling, the long-kerneled ears should be shelled separately from the short-kerneled ears. The planter plates should be tested so as to get the plate that will drop the desired number of kernels each time. Having found the right size it should be marked so that at planting time no mistake will be made.

All of this seems like a good deal of care to take with the corn crop, but a big yield cannot be obtained from careless work. The average yield per acre for the corn belt states is near thirty bushels per acre, but many careful farmers are averaging seventy-five bushels, and many frequently raise a hundred bushels per acre. Such farmers take great care in selecting and preparing their seed corn and then use equally as great care in planting and cultivating the crop.

CHAPTER X

WHEAT

WHEAT is probably the oldest known cereal. The oldest books of which we have any knowledge speak of wheat, and specimens have been found in places which indicate that wheat was known before our oldest books were written. Without doubt wheat is a native of that part of the Old World where civilization first began. There are several mythological stories of its origin, one of which places its origin in Sicily, whence it was distributed to Greece, Egypt and China. The earliest descriptions and the oldest specimens seem to show that wheat has had for centuries the same appearance that it now has. Wheat was brought to America by the earliest explorers and settlers.

Wheat grows successfully through a very wide range of latitude. In North America it will grow as far north as 60 degrees, and good crops can be raised in Cuba. In the Old World, good crops are raised in Egypt and Algeria, and as far north as 64 degrees in Norway. Extreme heat does not seem to be injurious unless it is accompanied by too much dryness or too much moisture. However, there is a great deal of difference in the quality of wheat under these ranges of temperature. That grown in the colder climates has a harder grain than that grown in warmer regions. The nitrogenous element in wheat is called *gluten*. When wheat is chewed a

while in the mouth a sticky mass like chewing gum is obtained. This is gluten. The more elastic this gluten is the better such wheat will be for making flour to be used for bread. The hard, red, flinty wheats have the best quality of gluten, and hence make the highest grade of flour. The whiter, softer and more starchy wheats make good flour for pastry purposes. Wheat raised on soil rich in humus, in a climate where the summers are dry and hot, usually has hard red kernels which contain gluten of the best quality for bread making.

Even in the United States there is so much variation in the quality of wheat, due mainly to climate, that the United States Department of Agriculture has divided it into eight wheat districts. We cannot give a detailed account of each of these districts, but it will probably be enough to say that the wheat of the southern and New England states generally is rather soft and starchy and does not make good flour. The wheat grown in the states north of the Ohio River has a harder grain, but not hard enough to make the highest grade of flour. The spring wheat grown in the Northwest and the winter wheat of Iowa, Nebraska and Kansas have the hardest grains and make the highest grade of flour. In parts of Texas, Oklahoma, Kansas and South Dakota durum wheat is being raised extensively. This wheat is better adapted to dry and hot summers than other kinds of wheat. Durum wheat is used largely in making macaroni, and on this account is frequently called *macaroni* wheat. The wheat raised in the Rocky Mountain and coast states is generally white in color, soft and starchy. Hard wheats taken into this region and grown for a few years change so that they become soft and starchy.

Kinds of Wheat.—There are eight kinds of wheat: common bread, club or square head, poulard, durum, polish, spelt, emmer, and einkorn.

Common bread wheat. With this group almost every boy and girl in the central states is familiar. The varieties of this class furnish most of the wheat flour used for making bread.

Club or *square head wheat.* In this class the heads are usually a little larger at the top than at the base and are quite distinctly four-cornered. The varieties of this class have stiff straw and the heads do not shatter easily. The grain is used largely for making crackers and breakfast foods.

Poulard wheat has stiff straw, stands dry weather well, and is not attacked by leaf rust. It is raised mostly in the Old World countries. Some varieties are used for making macaroni.

Durum wheat. The gluten in this wheat is of excellent quality and the grain is used largely for making macaroni and similar pastes. The wheat stands dry weather well and is not attacked by leaf rust.

Polish wheat is raised mostly in countries along the Mediterranean Sea and is used for making macaroni.

Spelt is very little used for human food, being fed mainly to live stock as oats are fed. The grain is always held tightly in the chaff and cannot be threshed out. Instead of shattering, the head of spelt breaks in pieces. It is grown mostly in European countries.

Emmer also has its grain held in the chaff, but not so tightly as that of spelt. The head also easily breaks in pieces. It is nearly always sown in spring, while spelt is sown in the autumn. Emmer is well adapted to our western states and is being grown to a considable extent for feeding to live stock. In Europe it is used by the peasants for food.

Einkorn is much like emmer, but is not at all improved over the wild form. It is entirely unknown in the United States and is little raised in Europe. It has about the same characteristics as emmer and spelt.

Characteristics of the Common Bread Wheats.—As the bread wheat varieties are practically the only ones grown in the central states, we need give special attention only to this group. The varieties may be divided into two large classes in two ways: (1) The one which has awns or beards on the heads, called bearded varieties, and the one in which the heads have no beards, called smooth or bald varieties. (2) White varieties in which the grain is whitish or yellowish in color, and red varieties which have their grains red or amber colored.

There is very little difference in the yielding power of these different classes. The Ohio Experiment Station made 144 trials with white varieties and 627 trials with red varieties. The white averaged 27.3 bushels per acre and the red 27.8 bushels. In 342 trials bearded varieties gave 25.9 bushels per acre and in 418 trials smooth varieties made 26.4 bushels. These differences are not large enough for us to favor one more than the other so far as yield is concerned. The fact of the matter is that *some* varieties are better than others, and they may be either smooth or bearded, or they may be either white or red.

Red wheat as a rule is harder grained and usually contains a better quality of gluten. For this reason it is generally preferred for making flour to be used for bread making. Bearded varieties seem to be more liable to blow down or lodge when full grown than smooth varieties, but bearded varieties are attacked by rust less than smooth varieties. This same state-

ment is true concerning red and white varieties. A great many varieties of wheat are introduced into the United States from the wheat growing regions of Turkey and Russia. Most of these varieties are bearded, weak-stemmed, so that they lodge easily, and have hard, red grains which make excellent flour.

A farmer in selecting a variety of wheat for his farm should be guided by his soil and climate and the experiences of his neighbors as well as his own. Some varieties are better adapted for growing on clay soils than on loam soils, and some do better in rich "bottom" lands than others. Then, too, the amount of rainfall and the temperature in a region affect wheat varieties. Some can do well under dry, hot conditions, while others will be failures under the same conditions.

Wheat Culture.—*Soil.*—Wheat is best adapted to a clay loam soil. It should not be sown on sandy or muck soils. It grows too rank and the heads do not fill well on muck soils, and sandy soils are apt to be too dry at heading time for the heads to fill well. By *filling* is meant the development of the kernels in the heads.

Preparing the Seed Bed.—Wheat will usually repay all extra pains taken in the making of a proper seed bed. A proper seed bed is one that has about two and a half to three inches of fine loose soil over the top of a firm under-soil. Such a seed-bed permits the seed to be covered deep enough and at the same time induces a movement of capillary moisture upward to supply the needs of the young plant in autumn.

Land for wheat is usually plowed in the autumn. The earlier it is plowed the better. It is better to plow six weeks before sowing than two weeks or one week before sowing. As soon as plowed the soil should be rolled and harrowed.

If it is mellow, harrowing may be all that is necessary. The object of early plowing and preparing is to allow the connection of the furrow-slice to be reëstablished with the undersoil. If no rolling or harrowing is done, the plowed land will dry out and be drier than if it had not been plowed. The field should be harrowed several times before the wheat is sown. If it is plowed six weeks before sowing, it would be well to harrow once a week until the wheat is sown. This would keep the weeds killed out and would stir the soil so that the sun and air would have a chance to make plant food ready for the young plants. The bacteria in the soil will be more active when the soil is plowed early and prepared in this way.

Frequently wheat is sown in standing corn or after the corn has been cut. On fertile land this will usually give good results, but the wheat can hardly ever be put in in as good shape as when sown on plowed land. Also, the corn plants have used up a good deal of the ready plant food in the soil and the young wheat plants are likely to suffer from lack of food. If wheat is sown on corn ground, the land should be cut up with a disk harrow and then leveled with a spike-tooth harrow. A spring-tooth harrow also does good work in loosening the soil in the place of a disk harrow.

Date of Sowing.—The best date to sow wheat cannot be definitely stated. It will depend mainly upon the latitude of the place. The Hessian fly is likely to attack the early sown wheat, and when there is danger from this attack sowing should not be done until after the date of the depositing of the fly's eggs. This date can be found out by writing to the Entomologist of your Experiment Station. It is desirable to sow rather early in the autumn, if possible, because in so

doing the wheat plants are enabled to make a strong growth and so better stand the cold weather of winter.

Rate of Sowing.—Experiments have shown that six to eight pecks of wheat sown per acre will give better yields than less. Most farmers do not sow enough seed. Where the seeding is not thick enough the plants try to make up for the lack of seed by "stooling" or "tillering." By *tillering* is meant the starting of a number of stalks from one seed. At first only one stalk starts, but when conditions are favorable, one, two, three, or more, extra stalks start from the base of the first plant, so that there may be several heads of wheat produced from one seed. Moist, cool weather and thin sowing are favorable to the tillering process. However, it is better to sow enough seed and not depend upon the stooling out.

Wheat should be sown with a drill. The drill distributes the seed more evenly and covers it better, thus ensuring a better stand of plants. Scattering seed by hand, or broadcasting, is an old-time method, and should not be practised by careful farmers. Where sown broadcast the seed is covered with a harrow. This does not cover evenly, and since the seed cannot be distributed evenly by hand, we cannot expect a good crop from such a method of sowing.

Harvesting.—Wheat is ripe when the kernels are no longer soft and mushy. This can be told by pinching the kernel between the thumb and finger. At the time the kernels begin to harden the stems and blades begin to turn yellow. Farmers usually tell when wheat is ripe enough to cut by the yellow color of the straw. Wheat should be cut as soon as the kernel becomes hard and tough. If cut later, the grain will shatter out of the head and be lost. When wheat is *dead* ripe the heads begin to droop. It is now over-ripe and does

not make as good flour, nor as large a quantity, as when cut earlier.

As soon as cut and bound by the binder the sheaves may be set up in shocks. A shock is usually composed of twelve sheaves, ten of which are stood upright on the stubble end so as to make a round or long shock. The other two are bent at the band and put on top of the shocks as *caps* to keep the inside of the shock from getting wet. After the shocks have stood for a week or ten days they may be threshed or they may be stacked and threshed at a later time. Sometimes the shocks are left standing for several weeks before threshing, but this is risky, because of the loss from wet weather and in some cases from birds.

Sweating.—When wheat is first stacked it draws damp, "sweats" as the farmers say, and gets warm. This is a perfectly natural process, and in a few days it will begin to cool off and dry out. This sweating improves the quality of the grain. If the grain is threshed before it sweats, the sweating will take place in the bins, and here it frequently gets so hot that it is spoiled for future use. In such cases the wheat should be stirred every day for a few days.

CHAPTER XI

OTHER CEREALS

Oats.—Oats are a crop that was brought into use first in the Old World. Their use does not seem to be so old as that of wheat, but they have been known and used for centuries. They are raised mostly within the north temperate zone. The north-central part of the United States and Canada grow most of the oats produced in America. However, oats growing is extending in the southern states. Oats have come to be largely used for making breakfast foods, as well as for live stock feeding, so that their production is increasing.

Oats are adapted to cool, moist climates, and for that reason the oats grown in northern climates are of better quality than those grown in southern sections. The northern varieties weigh more per bushel and have fewer beards on the hulls of the kernels. Southern varieties are frequently so beardy that they will not feed through the drill for sowing. The varieties of northern climates are usually white in color (there are some black varieties); those of the south are dirty white, dun and reddish brown.

Soil and Preparation of Seed Bed.—Oats are suited to any soil except the very rich and the very sandy. A clay loam soil well drained is best. Oats usually do not need manuring and fertilizing like wheat, for they depend upon the left-over fertility of the last crop. In the corn belt states oats are

largely sown without plowing the ground. The crop is usually sown on corn stubble ground, in which case the land is disked and harrowed and the oats drilled. On prairie farms most of the crop is sown with broadcast seeders and the grain covered by disking and harrowing. However, land which has been plowed and carefully prepared will usually bring larger results than land not so carefully prepared.

Seeding.—Farmers try to sow their oats as early in spring as possible. There are two reasons for this: one is to get the work out of the way and the other is that oats do better when sown in the cool and moist part of the growing season. South of the latitude of the Ohio River a great deal of oats is sown in autumn. In the north the cold winter freezes the autumn-sown oats and kills them. Seed of the best quality only should be sown. It should be run through a fanning mill and all the light grain winnowed out. Experiments by Professor Zavitz, of Ontario Agricultural College, show that plump, heavy seed will give a larger yield than common seed. The amount of seed sown per acre varies a great deal. It depends upon the soil and the method of sowing. On rich land not so much seed need be sown as on poor land, because plants will be stronger and stool out more. When sown with broadcast seeders more seed should be used than when the seed is drilled. Two and one-half bushels per acre is an average sowing. Many farmers sow two bushels per acre, while others sow much more. It is said that as much as seven and one-half bushels per acre are sown in Scotland.* Heavy seeding generally gives best results. Oats should not be covered too deeply; about one inch deep is best when the land is in good condition.

* Bailey's *Cyclopedia of Agriculture.*

Harvesting.—What has been said about the harvesting and threshing of wheat applies also to oats. Oats should stand in the shock until they are well dried out before being stacked or threshed.

Varieties.—There are many varieties of oats. All may be classed in two large groups, the *spreading* oats and the *side* oats. In the first group the branches of the oats head spread out in all directions from the central part, while in the second group all the branches seem to be on one side of the head. The spreading varieties are considered better yielders than the side varieties. Black varieties are not generally considered such good yielders as the white. There are some varieties which have yellowish hulls. In the southern states the varieties are nearly all reddish-brown or gray. There are varieties which have very loose hulls around the kernel, so that in threshing the kernel is completely hulled out. This kind of oats is called "hulless" and is not a profitable kind to grow. Oat varieties differ a good deal in their time of ripening. As a rule those which ripen medium early are the best yielders.

Rye.—Rye has been known in the Old World for more than 2,000 years. However, it is not so old as wheat and barley. It originated along the Mediterranean Sea and in Western Asia. It is said still to grow wild in the unsettled parts of those regions. Rye is not so important as the other cereals. The amount raised seems to be decreasing. In this country it is raised partly because of the value of the straw.

Culture of Rye.—The cultivated plant became known first in North-eastern Europe. Rye is adapted to a wide range of climate and does better than wheat in extremely cold

regions. It will grow on soil too poor to produce good crops of wheat. It is also grown on land on which wheat is killed out by the winter. The seed-bed for rye should be prepared exactly as for wheat. Rye is usually sown a few days earlier than wheat, but may also be sown quite late. About one and a half to two bushels of seed per acre are sown. The harvesting and threshing are the same as for wheat, but extra care must be taken that the grain is quite dry before storing it in bins, for it will mould very easily.

Varieties and Characteristics.—There are few varieties of rye, probably owing to the easy mixing of varieties when sown close together. Rye grows much taller than wheat and the kernels are not completely covered by the chaff. Rye heads out and blossoms much sooner than wheat, but it ripens at about the same time. The straw from rye is quite valuable for packing purposes, because of its length and toughness. Rye is seldom injured by insects, smut, or rust. A disease called ergot sometimes attacks it. This will be spoken of in another place.

Barley.—The history of barley is as old as that of wheat. In ancient Egypt it was used as food for man and beast and also for beer. Down to the sixteenth century it was the principal bread plant of the civilized world. With the development of wheat culture and the introduction of potatoes from America its use began to decrease.

Culture.—Barley will grow under a wider range of climate and soil conditions than any other cereal. It will grow well in regions of small rainfall and it matures in less time than oats and spring wheat. Barley comes to its highest perfection on rich, sandy loam soil, well-drained. It should not be grown in a field that has had a root crop, *i. e.*, turnips or

sugar beets, the year before; nor should it be raised several years in succession on the same field.

The preparation of the seed-bed for barley is the same as that for wheat or oats. In some parts of the country barley is sown in autumn, but in most places it is sown in spring. From one and a half to four bushels of seed per acre are sown. Barley does not stool out much, hence a good deal of seed is required. Barley should be harvested before it becomes over-ripe, and great care must be taken to shock it so that the heads do not become discolored by rain and dew. This care is necessary if the grain is to be sold to brewers. If the grain is to be fed to live stock such care is not so necessary.

There are not many varieties of barley. They are classified as six-rowed, four-rowed, and two-rowed varieties, according to the arrangement of the grains on the head. The varieties may also be grouped as bearded and beardless. The beardless varieties are quite new and were developed because of the strong objection by farmers to the beards on the common barley. In most varieties the hull remains attached to the kernel after threshing, but there are a few varieties in which the kernels thresh out clean like wheat.

Rice.—While rice is not grown in many states of the Union, it has become such an important crop in some of them that a brief mention of it here will not be out of place. Rice furnishes food for more people than any other plant. It is cultivated in the warm regions throughout the world. In the United States its culture is limited to the Gulf States and Arkansas. Texas, Louisiana and Arkansas produce most of the rice raised in this country.

Culture.—The rice plant grows best in a rich, clay loam soil. The rice fields are usually located along streams or

where they can be easily flooded with water. The land is prepared as for wheat and the grain is sowed in drills or broadcast at the rate of about fifty-five to eighty pounds per acre. As soon as the plants come up water is turned on from the streams or is pumped on from large wells. This is called "flooding." The flooding is accomplished by means of canals run across the fields and so arranged that by means of "gates" in the banks the water can be turned on or shut off as desired. The object of the flooding is to kill grass and weeds and to furnish an abundance of moisture. The field is left covered with water for several days; then it is withdrawn and the field allowed to dry a few days, when the water is turned on again. The process of flooding and drying is repeated until harvest time, when the water is withdrawn to allow the ground to dry so that binders can be used. Rice is cut before it gets fully ripe, just as the straw begins to turn yellow. It is carefully shocked and usually stacked. When threshed the hull remains on the rice kernel and it is necessary to run it through another mill to remove the kernel. The hulled grain is then run through another mill, which polishes it, and it is ready for market. Much of the work in rice growing is done by hand, but on the large fields modern machinery is being brought into use.

Millet.—In the United States millet is not grown very extensively for seed and such as is produced is used for bird seed, and for sowing future crops. However, in Russia, China, and India, millions of bushels of millet seed are used for human food. In those countries it has been used for food for centuries. Russia grows about eighty million bushels of millet annually. Japan uses about thirty-five million

bushels of seed each year for human food, and in India thirty-five to forty million acres of millet are grown annually. The kinds of millet and their culture will be described in the chapter on forage crops.

Buckwheat.—Buckwheat is a native of the Old World, where it has been cultivated in nearly every country for centuries. It is not properly a cereal, but because its seeds are used for human food it is spoken of in this chapter. It is closely related to such plants as rhubarb, sour dock, and smartweed, and if the seeds of these plants be compared with the buckwheat seed it is easily seen that they resemble each other very much. The name buckwheat seems to come from a German word, *buchweizen,* meaning beech-wheat, a name given to it because the seed looks so much like a beech-nut.

Only about fifteen million bushels of buckwheat are raised in the United States. New York and Pennsylvania grow about two-thirds of this amount. Buckwheat grows best in a cool, moist climate, although warm weather is helpful during the first few weeks of growth. Hot weather and showers at flowering time are almost sure to cause a failure, because the seed does not form well from the blossoms. Buckwheat ripens seed in a shorter time than any other grain crop, eight or ten weeks being enough time to grow a crop of buckwheat.

Buckwheat grows best on light, well-drained soil. It does well also on poor land, or land poorly farmed. Buckwheat is usually not manured or fertilized, but it will respond to applications of manures and fertilizers as well as any crop. It leaves the land in good shape for wheat or potatoes. It is said that oats and corn do not do well after buckwheat. The land should not be heavily fertilized. Also, farmers should not attempt to grow buckwheat on very rich land, for it will

easily lodge and a good yield will not be obtained. The land should be plowed early in spring, harrowed down, and harrowed at various times to kill out weeds until time to sow. Often the land is not plowed until late, and then it is not put in good shape for the seed. The seed is sown about the first of July at the rate of about one bushel per acre. It may be sown in drills or broadcast.

Buckwheat keeps on blossoming and producing seed until killed by frost. The crop should be cut before heavy frosts. Some of the green kernels will mature as the plants dry out. The crop is usually cut with a self-rake reaper or with a mower. The threshing should be done as soon as the stems are fully dried out. The grain should not be stored at first in large piles or tight bins as it heats easily and spoils.

Cow-peas and Soy-beans.—The growing of these plants will be spoken of in the chapter on forage crops, for they are grown as much or more for hay than for the seed. The seeds of both of these plants are used for human food and for live stock. In the southern states cow-peas are highly prized for table use, and in Asia the soy-bean furnishes a part of the human diet. In America, however, the seeds of both plants are used mainly for feeding live stock. Cow-peas are pastured off by hogs or ground for feeding to cattle. Soy-beans can be fed in the same way. Soy-beans have been fed to all classes of live stock with good results. Neither cow-pea nor soy-bean seed should be fed alone, but should be mixed with four or five times its weight of corn or other grain.

CHAPTER XII

ROOTS, TUBERS, BULBS

Soils and Preparation.—In a general way all root crops do best in soil which is not too heavy. A loam soil with a good proportion of fine sand in it seems to be best, for such a soil permits the roots to develop smooth and uniform. The plowing for root crops should be deep, for all the true root crops have long tap roots which strike deeply into the soil, and if the soil is loose deep down they have an opportunity to grow large and well formed. After plowing the seed-bed should be made as fine as possible. The seeds of most of the true root crops are quite small and need a fine, mellow seed-bed or they will not germinate well. If the land is plowed early in spring and then harrowed several times until the time of planting, the weeds will be pretty well killed out. One should not try to raise root crops on weedy land.

Carrots.—The carrot is the best root for feeding to horses. It is also used for human food. Carrots require rich, mellow soil, free from weeds. The young carrot plants are quite small and delicate and weeds easily choke them out. The seed is sown in drills eighteen to twenty-four inches apart, from the middle of May to the middle of June, at the rate of one and a half to two pounds of seed per acre. Owing to the small size of the plants some hand work will be necessary

in the first cultivation. The plants should be thinned until they stand about four to six inches apart in the row. They grow slowly at first and require careful attention. The roots should be gathered before freezing weather, dried in the open air, and then stored in a cool, dry place. Carrots will yield from fifteen to twenty tons per acre.

Mangel-wurtzels.—These are commonly called mangels. They are more widely used as a root crop for winter feeding than any of the other roots. The varieties differ in shape, color and size. The name of a variety is frequently made up of words indicating all three of these characters, as, for example, the Giant Long Red. The shapes are of three kinds, the globe, ovoid, and long. There is little difference in the value of these sorts. The globe and ovoid sorts are probably better than the long varieties, being more solidly fleshed and better keepers. Mangels grow with part of the root out of the ground. The long varieties have as much as half of the root above ground. This part of the root is not so good for food as the underground part.

Mangels require a deep surface soil so that the roots can grow downward without being hindered. Subsoiling may be advisable in some cases in order to get a deep seed-bed. Seed is sown in drills twenty-four to thirty inches apart, in May or early June, at the rate of four to six pounds per acre. The seed sprouts slowly and the growth at first is slow, so that a good deal of care in cultivation is necessary to keep the weeds down. The plants should be thinned to eight to twelve inches apart in the row. The roots are harvested before hard freezing weather and stored in cellars or bins for winter feeding. A box-stall closed up makes a good place to store them. In gathering the crop the tops should be twisted off by hand

rather than cut off with a knife, as the roots keep better when so topped. Twenty to thirty tons of roots per acre is a common crop.

Sugar Beets.—Sugar Beets are improved mangels and require almost exactly the same treatment. The sugar beet contains more sugar than the mangel and in some states is extensively raised for the manufacture of sugar. About twice as much seed is required per acre and the plants should be about twice as close in the row. For sugar production roots weighing about a pound are desired. Small sized roots are richer in sugar than the large sized ones. When grown to feed, large roots are desirable, for they require less labor to harvest. Fifteen to twenty tons per acre are raised under ordinary conditions.

Parsnips.—Parsnips are raised mainly for table use in America, but they also furnish an excellent food for milch cows. In the Island of Jersey, where Jersey cattle came from, they are extensively raised for that purpose. The parsnip is very deep-rooted and requires deep soil for good results. The seed is sown in spring in rows eighteen to twenty-four inches apart, using about four pounds of seed per acre. The plants should be cultivated and thinned like carrots. Parsnips are not injured by freezing and only such as are needed for winter use need be gathered. They yield ten to fifteen tons per acre.

Turnips.—There are two classes of turnips, the English and the Swedish. The English turnip is the kind usually grown in gardens and truck patches for table use, and the seed is usually sown in summer after some early crop, like sweet corn, potatoes or peas, has been harvested. It is nearly always sown broadcast without much attention being given to the

amount of seed, but the proper amount is about two or three pounds per acre.

English turnips grow very rapidly and are soon large enough to use. They produce at the rate of ten to fifteen tons per acre.

Swedish turnips are frequently called ruta-bagas and this is generally shortened to "bagas." They are also called "Swedes." Swedish turnips are used mostly for feeding live stock, but can also be used for the table. They grow larger and require a longer season to reach full growth than the English turnips. They will not grow so well in warm temperate climates as the English turnips, but are best suited to the climate of our northern border states and Canada. They should be sown in drills about two feet apart, using about one pound of seed to the acre. They should be cultivated the same as other root crops and thinned to five or six inches apart in the row. Twenty or more tons to the acre can be grown.

All kinds of turnips are hardy and do not need to be gathered until the ground begins to freeze. It is better to store turnips in trenches or mounds of earth, for when put into dry cellars they lose moisture and become pithy and not good to use.

Potatoes.—Potatoes are not roots, but tubers. The potato is a native of America. The Indians were growing it when the first colonists came to this country. When the potato was introduced into the Old World it became a source of food for millions of people. In this country it is used chiefly for food. It is also used for the manufacture of starch, but not to such an extent as in other countries, for we have Indian corn which is a cheaper source of starch.

Potatoes do best in loam soils having a tendency to become

sandy. Muck soils have been found quite favorable to potato growing A clover sod on well-drained loam soil is, perhaps, the best possible foundation for a large yield of potatoes. The land should be plowed deeply; and if it is plowed in the fall and then again in the spring it will be all the better, for potatoes like mellow soil. It should be thoroughly pulverized as deep as plowed. The land can be manured with stable manure, but large potato growers prefer to use commercial fertilizers, for manure is likely to cause scab and rot, two diseases that are quite damaging to the crop.

Where potatoes are planted by hand it is a good plan to furrow out the field with a single-shovel plow and drop the seed potatoes in the bottom of the furrow. The seed planted for the future crop is not the real seed of the potato, but a tuber or a piece of one. This is called the *seed-piece.* If potatoes are planted in furrows it will not be necessary to ridge the rows in order to keep the new potatoes covered. The new potatoes do not form any lower down in the soil than the position of the seed-piece, so that there is danger of the new potatoes being too near the surface and becoming green from the sun, a condition which spoils them for use. When potatoes are grown on a large scale they are planted by a machine drawn by horses. This machine makes a furrow, drops the seed-piece and covers it. The seed-pieces planted are usually prepared beforehand by cutting a whole potato into two or more pieces according to its size. Every piece should have one or more "eyes." The "eye" is the place on the tuber where the new plant starts. It is best to let the cut pieces lie for a few hours until the cut surfaces have dried. The seed-pieces will then not rot so easily in the ground if the weather is not favorable for growth.

Potatoes are usually planted in drills three feet or more apart and the seed-pieces dropped about fifteen to twenty inches apart in the row. They may also be planted in hills three feet or more apart, dropping two or three pieces in a hill. The seed-pieces should be covered about four inches deep, or planted about two inches deep in a slight furrow and filled in by cultivation after the plants come up.

Cultivation can begin as soon as necessary. Even if the plants are not up, the rows are easily followed, and if a slight covering of soil is thrown over the row no harm is done, but rather good, for the plants will come through it and the row will have fewer weeds. The purpose of cultivation is, as in other cultivated crops, to keep down weeds and preserve the moisture. Level cultivation should be given and it may continue until the plants come in blossom, or so many tops cover the row that they are injured by the horse and cultivator.

Early potatoes are usually dug as soon as possible and put on the market. Late potatoes are allowed to mature fully before digging. They are then marketed for winter use or stored in cellars to be sold out during the winter or early the next spring. Cellars should be kept just a little above the freezing point. If too warm the potatoes produce sprouts and their quality for food is thereby injured. Small patches are usually dug by hand, but in large fields potato-diggers drawn by horses are used. Care should be taken not to dig potatoes when the ground is too wet, for the soil will stick to the tubers and spoil their appearance. An ordinary crop is 100 bushels per acre, but professional growers expect from 250 to 300 bushels per acre. Yields as high as 500 to 1,000 bushels per acre have been reported.

Sweet Potatoes.—While the sweet potato is called a tuber it is really only a thickened root. The sweet potato is of tropical origin and does best in the southern states, but is grown more or less in nearly all the northern states. The quality, however, is not so good as when grown farther south. Sweet potatoes are best adapted to sandy loam soils. The plants are started by planting seed potatoes in hot beds. Sprouts soon start up. These are pulled off and reset where they are wanted to grow. The plants soon begin to grow rapidly and need little care after the vines begin to form, except to keep down large weeds. The vines should be cut loose from the hills before killing frosts, as the potatoes are injured in quality if the vines are killed by frosts while still attached. The potatoes should be dug before cold weather and stored in a cool, dry place.

Artichokes.—The artichoke is a tuber. It is a tall growing plant with a yellow blossom resembling the sunflower. Artichokes are not raised extensively and are used almost entirely for feeding hogs, although sometimes for table use also. They are planted like potatoes and are usually not cultivated very much, but cultivation gives best results. The plant lives over from year to year and does not need replanting. In fact, when they are not cared for, artichokes run wild and become troublesome as weeds. Hogs are turned into the field in autumn and are allowed to harvest the crop by rooting out the tubers. Enough will be left in the ground to produce a good crop another year. Hogs are very fond of artichokes and gain in size and flesh quite rapidly while feeding on them.

Onions.—The onion is a bulb and is used by almost every one as an article of food. Onions are never used as food for live stock. Onion growing in some states has become quite

extensive. New York, Ohio, Indiana and the New England states produce the bulk of the onion crop.

Onions do best on well-drained loams which are not very sandy. Large crops are also raised on muck soils, when properly fertilized. For onions the soil should be thoroughly

19. AN ONION FIELD
A harvesting scene in an Indiana field
By courtesy of the Indiana Experiment Station

prepared. If the land is plowed in the autumn and again in the spring it is all the better. It should be pulverized, so that the seed will have the proper chance to sprout. Sometimes hand raking is done to get a surface of fine soil. Muck soil is more easily prepared than loam. Land for onions should be as free as possible from weeds. When once a field has been put in shape for onions, it is usually planted with them three or four years. Since weeds are not at all desir-

able, stable manure is not much used for fertilizing, but commercial fertilizers are largely used. Fertilizers containing a good deal of potash and phosphoric acid are desirable. Land used for onion growing should be limed every six or seven years.

The onion seed should be planted in spring as early as the field can be prepared. Where onions are grown on a large scale the seed is sown with special hand machines. Fourteen inches apart is about the right distance for the rows. About four pounds of seed per acre are used.

Onions require careful cultivation. This is usually done by hand labor with hoes and hand cultivators. Those who thin and weed the rows usually work on hands and knees. Onions are ripe when the tops begin to fall down and die. They are then pulled and thrown into rows to dry. When the tops are fully dry, the onions are ready to store. Some growers store them without cutting off the tops; others cut off the tops. They are usually stored in bushel crates.

If the onions are to be sold to shippers soon, the farmer usually ranks up the crates in the field, covering them to keep off rain. Some growers have a special shed for storing, which has sides that can be opened to give a circulation of air. When stored for winter they are put into cool, dry cellars, and sometimes into large warehouses. Onions are heavy yielders, giving 500 to 600 bushels per acre for ordinary crops and frequently as much as 1,000 bushels.

CHAPTER XIII

FORAGE CROPS

A *forage* crop is one used for coarse feed for live stock. Sometimes the material used for forage is called "roughage." Forage crops are used in four ways: 1. *As hay.* The plants are cut green and dried in the sun. Grasses and clovers mostly are used for hay. 2. *As silage.* The plants are cut green and run through a machine which cuts them into short pieces and these are stored in an air-tight bin, called a silo. Green corn is commonly used for silage. 3. *Soiling* is cutting the plants green and feeding them at once to animals in their stalls or pastures. Sorghum, peas and oats, and corn are crops often used for soiling. 4. *As pasture.* The crop is eaten where it grows.

Hay.—For hay many kinds of plants are used, chiefly grasses, clovers, millets; cow-peas and soy-beans.

Timothy and orchard grass are the grasses most commonly used. Timothy does well on heavy soils like clay and loam. It also grows well on muck soils, but is apt to become too coarse stemmed. The seed is usually sown in autumn with wheat or rye. After the grain is cut the timothy occupies the field and the next year is cut for hay and may be used several years for cutting. Timothy is sometimes sowed alone in the fall on well-prepared land. It then produces a crop the next year. A bushel of seed is used for about six acres of

land. It should be cut for hay for horses just after the bloom begins to fall. For cattle it should be cut just as it is coming into blossom. It is then not so woody.

Orchard grass will grow on drier soils than timothy. The seed is sown in autumn or spring on wheat ground or loam. It takes about two bushels of orchard grass seed to the acre to ensure a good stand of plants. Orchard grass is ready to cut for hay before timothy, so the two grasses should never be sown together. It should be cut as soon as it begins to blossom, or else the stems will get too firm and woody to make good hay.

Red Top is a grass much used for hay in the eastern states, but it does not give as heavy a yield per acre as timothy. A good timothy or orchard grass crop should give two tons of dry hay to the acre.

The clovers are much used for hay, especially for cattle and sheep. Timothy and orchard grass are much better for horses. There are four clovers used for hay.

Red Clover.—This clover usually lives two years, hence it is a biennial. A *biennial* is a plant that produces blossoms and seeds the second year after the seed is sown. It grows best on loam soils. It is sown broadcast in the spring on wheat ground or with oats. Usually the seed is sown in February or March on wheat ground at the rate of one bushel to five or six acres of ground. The seed is worked into the ground by the freezing and thawing, and when the weather becomes warm enough it sprouts and grows. Sometimes the seed is sown later and covered by harrowing with a spike-tooth harrow. The harrowing does not injure the wheat. After the grain is cut the young clover plants grow up rapidly, if the weather is good, and furnish fall pasture. The next

year the plants produce blossoms and are cut for hay. Red clover soon grows up again after being cut and blossoms the second time. This second crop can be cut for hay or be allowed to ripen and be cut for seed. When a plant goes to seed it usually dies and there is no plant for next year.

Making Clover Hay.—In cutting clover for hay, the green plants are cut when about one-third of the blossoms have begun to turn brown. At this time the clover plants will make the most nutritious hay. The cut plants are allowed to lie in the swath until almost dry, when they are raked into windrows where they may dry more. Then the windrows are gathered in piles or haycocks. These may stand in the field a day or two or be hauled to the barn at once. In making hay from any of the clovers, it should be the aim of the farmer to save all the leaves, for they contain much food material.

Mammoth Clover.—This is also called Big English clover and sometimes Pea-vine clover. It grows larger than the red clover and makes only one crop in a season. Mammoth clover can be told from red clover by the absence of the crescent-shaped light green spot on its leaflets, which is found on the leaflets of red clover, and by its larger size and later blossoming. Mammoth clover grows well on wetter soil than red clover. The seed is sown at the same time and at the same rate as red clover. Mammoth clover does not make quite as good hay as the red clover, because it is coarser and has more fuzz on the stems, which makes the hay dusty. Dusty hay gives horses the heaves. Mammoth clover does well to grow with timothy for mixed hay, because the two plants blossom together. Red clover can be grown best with orchard grass, for their time of blossoming is the same.

Crimson Clover.—This is also called German clover. It lives only one year, that is, it is an annual. The seed is sown in the autumn, usually August for the corn-belt states. The next spring it heads out and produces beautiful, deep red blossoms. This clover does not stand the winters north of the Ohio River very well, hence it is not largely grown there. The hay is too woolly to be first class. This clover is best for pasture and green manuring, and is used quite largely in the southern states for such purposes. Crimson clover does best on loose, sandy loam soils. The seed is sown at the rate of fifteen pounds to the acre.

20. THE LARGE ROOT SYSTEM OF THE CLOVER PLANT

Showing the large number of nodules on the roots. It is these that make the clover plant so beneficial to the soil

By courtesy of the U. S. Department of Agriculture—Bureau of Plant Industry

Alsike Clover, also known as Swedish Clover. This clover has finer stems and leaves than the other clovers. The blossoms are beautiful pink and resemble those of white clover except that they are more deeply colored. Alsike clover does well on wetter soils than any of the other clovers. It makes finer hay than any of the others. Only one crop can be cut

from this clover in a season. This crop can be used for hay or for seed. Alsike clover does not die out after producing seed like the other clovers, but continues to live for several years. It is a perennial. It is a good clover to sow with timothy, as both plants blossom together and so are ready to cut at the same time. Alsike and timothy are good to sow together on wet lands and on muck lands. It takes about six pounds of seed to sow an acre. The seed is sown in the spring.

Other Clovers.—Bur clover and Japan clover are not real clovers. They are grown in the southern states and are there quite useful, but they have no place on the farms in the north. Bokhara clover or sweet clover is considered a weed in most places, but some attempts have been made to use it for hay, especially in the South. It grows in waste places and along roadsides. It has white blossoms and gives off a pleasant odor when wilting. It is a good fertilizer for the ground. There is also a yellow variety of sweet clover.

Alfalfa.—Alfalfa is not a clover, but is closely related to the clovers. It is a legume and, like all the clovers and other legumes, gathers nitrogen to enrich the soil. Alfalfa originated in Western Asia. It is rather a new crop for the states east of the Mississippi River, but has been grown for many years in the dry western states. It seems to do better in irrigated regions than elsewhere. Alfalfa grows best on well-drained sandy soils, but has been grown successfully on every kind of soil except wet. The seed may be sown in spring, summer, or autumn. Best results have been obtained in Ohio and Indiana from sowing the seed in summer or early autumn on land that was plowed in the spring and kept free from weeds by harrowing. The amount of seed sown is about twelve to

fifteen pounds per acre. Alfalfa lives for many years when once it gets a start. The plants are cut for hay when about one-fifth of the heads are in blossom. As soon as cut new

21. A COW-PEA PLANT

Some varieties produce more vines than this one

By courtesy of the Indiana Experiment Station

growth starts up and in a few weeks it can be cut again for hay. Usually three or four crops can be cut from the same field in a season. The hay is cured the same as clover, but more care needs to be taken to save the leaves, as they drop off easily as soon as dry.

Cow-peas.—The cow-pea is a leguminous, viny plant, very much used for hay in those states bordering on the Ohio River and in all the southern states. The use of the seed has already been mentioned. The cow-pea is an Old World plant, coming from Asia. It is more like a bean than a pea, for it has long pods like bean pods and the seeds of most varieties look like the beans which we plant in gardens. The blossoms are beautiful, resembling pea blossoms. The cow-pea grows well on sandy and loam soils. The land should be prepared as for corn. The seed is not planted until the weather has become warm, usually after corn-planting. The seed may be sown in drills, twenty-four inches or more apart, with the plants standing about three or four inches apart in the rows. Or, the seed may be sown broadcast with the drill or by hand. When sown in drills a half bushel of seed per acre is necessary; when sown broadcast about twice as much seed is used. If sown in drills the plants should be cultivated like corn. They should not be cultivated when wet with dew, for the leaves will be injured. Cow-peas may be cut for hay, or pastured, or cut green for soiling. When cut for hay the vines should be thrown into piles as soon as they are wilted, so as to save the leaves. When some of the pods have begun to ripen it is time to cut for hay. Cow-peas also make excellent material to turn under for enriching the land.

Soy-beans.—The soy-bean is a native of Japan. It will grow well farther north than the cow-pea. It is an upright growing plant with small, purplish or whitish blossoms, and short hairy pods containing two, three, or four seeds. The soy-bean is grown mostly for seed, but is also useful for hay, especially for sheep. The time, method, and rate of sowing are the same as for cow-peas. Care should be taken in culti-

vating not to cultivate when the leaves are wet with dew, for this sometimes injures the leaves. Soy-beans are cut for hay when the pods are about two-thirds grown and before any of the leaves begin to turn yellow. When the soy-bean plant gets ripe all the leaves fall off, so if hay is to be made it must be done while the plants are yet green. Soy-beans are also good to plow under for green manuring.

22. A TYPICAL SOY-BEAN PLANT
Notice the nodules at the base of the plant and on the roots. These are full of bacteria which gather nitrogen from the air
By courtesy of the Indiana Experiment Station

Vetches.—There are several kinds of vetch. The most common are spring vetch and sand, winter, or hairy vetch. The hairy vetch is more successful than the spring vetch. It is sown in the autumn, usually with rye or wheat, and cut the next spring before the wheat or rye is ripe, thus making a mixed hay. Vetches do particularly well on poor ground. It takes about three pecks of seed with a bushel of wheat or rye to sow an acre. Vetch should not be allowed to ripen seed or it may become a troublesome weed.

Millets.—There are several kinds of millets. All of them have come to us from the Old World. In India certain kinds of millets are raised for seed and used for human food. In America millets are raised almost entirely for forage. A small quantity of seed is produced, but it is used mostly for sowing again and for bird-seed. Millets are grown mostly as catch crops. A *catch crop* is one planted late in the season after it is seen that some other crop is going to be a failure, or, when the farmer finds that he will not have enough hay for his needs. Millet is one of the principal "catch crops." All millets are grass-like plants.

There are four classes of millets:

1. *Foxtail* millets when headed out look much like the weed called foxtail. There are many varieties of the foxtail millets. The best known varieties are Common, German, and Hungarian millets. The Hungarian is finer stemmed than any of the others and makes the best hay. Foxtail millets grow best on well-prepared loam soils. The seed is sown broadcast at the rate of one-half to three-fourths of a bushel per acre. It should then be covered lightly with a harrow. The seeds soon germinate, and the plants grow rapidly. As soon as millet heads out and blossoms it should be cut for hay. If the seed is allowed to form and get solid, the hay is not safe feed for horses. Millet is cut and dried for hay just as other grasses.

2. The *Barnyard* millets are quite different from the foxtail millets. They are coarser stemmed and have a more branched head. The seed is larger and not so heavy. This class of millets requires richer and damper soils than any of the others. The seed is sown at the rate of about one and a fourth bushels per acre. This millet is almost too coarse for good hay and is not much in favor with farmers.

3. *Broom-corn* millets are so-called because the heads of the plants are quite long and branching like broom-corn or sorghum. It is also called Hog millet. This millet is quicker growing than the others and produces a heavy crop of seed.

23. A PLOT OF GERMAN MILLET READY TO CUT FOR HAY
This patch was about five feet tall and made four tons of hay per acre
By courtesy of the Indiana Experiment Station

The stems are covered with short hairs, so that they do not make first-class hay. About three pecks of seed are sown per acre.

4. *Cat-tail millet.* This name is derived from the resemblance of the head to the cat-tail flag which grows in swamps. It is also known as Pearl millet and as Pencilaria. It grows six or more feet tall, and looks much like sorghum until it heads out. The stems are not so coarse as sorghum, but

much more so than any of the millets. This millet stands dry weather well and grows rapidly after it once gets a start. It is better to sow this millet in rows and cultivate it. It takes about one or two pounds of seed per acre, if it is drilled in rows three feet apart. This millet is not very valuable as a hay plant.

Teosinte.—Teosinte is a forage plant looking much like corn. It is adapted only to southern states, as it requires a long season in which to grow.

Indian Corn.—Sometimes corn is sown broadcast with a drill, or quite thick in rows two or three feet apart. Being so thick very little grain is formed. When cut and dried, corn handled in this way is called *fodder corn.* It is really corn hay. When corn is planted in the usual way and cut and shocked it is called *fodder.* When the ears have been shucked out, the stalks remaining are called *stover.* Fodder and stover are very common forms of forage in the corn belt.

Silage.—Many crops have been used for silage, but there is only one satisfactory crop. This crop is Indian corn. For silage, corn is planted in the usual way and given the same cultivation as when grown for grain and stover. When some of the lower leaves have begun to turn yellow and the husks on a few of the ears are getting ripe the corn is ready to put into the silo.

The silo is really a big barrel set on end and without a head in either end. It is made out of staves of wood held together with iron rods for hoops. The bottom is usually set on a concrete foundation. Some silos are covered with a roof, others are not. A roof is desirable to keep out rain and snow. A silo is usually from twenty to thirty-five feet high and ten to twenty feet in diameter. There are doors in the sides for

getting out the silage. A silo should be taller than its diameter, so that when filled the weight of the silage will keep it tightly packed. Almost all silos are circular in shape. Most silos are made out of timber, although many are now being made

24. FILLING A SILO

This is one of the best methods of preserving the corn crop

By courtesy of the Indiana Experiment Station

of brick and some of concrete. A silo should be air-tight around the sides, else the silage will spoil wherever the air strikes it.

In putting up silage, the corn is cut in the field by hand or with a binder, loaded on wagons, and hauled to the silo. Here it is run through a cutting machine, which cuts it into short lengths of one or two inches. This cut corn is blown into the top of the silo with a blower and falls in showers to the bottom. Two or three men work in the silo, spreading

and tramping the corn as it comes in. Silage should be tightly pressed down against the sides of the silo and well packed through the centre. When full the top can be covered with rotten straw to keep out the air, or it can be left exposed. A few inches of the top will spoil, but the rest will come out in the winter when it is fed as green and sweet as when it was put in in the fall.

Silage is a particularly good feed for milch cows, and dairymen use it a great deal. It is usually fed during the winter and spring months, when there is little other green material. Silage weighs forty pounds to the cubic foot. An acre of good corn will make about ten or twelve tons of silage.

Other plants like cow-peas, soy-beans, clover, sorghum, peas and oats, and millets have been used for silage, but they have not given as good results as Indian corn. The legumes do fairly well when mixed with corn. They usually ferment too much and produce undesirable acids in the silage.

Soiling.—Soiling crops are largely used by dairymen, and stockmen who are preparing animals for shows and agricultural fairs. A good soiling crop must be *succulent*, that is, full of juice, grow quickly, give a large yield, and suit the taste of the animals.

Sorghum is one of the best crops for soiling. The ground is prepared as for corn and the sorghum seed sown in rows about thirty inches apart. It takes about a half bushel of seed for an acre. The sorghum is cultivated like corn and grows rapidly after it gets a start. When it begins to head out it is ready to use. As much as is needed is cut and hauled to the animals each day. A good field of sorghum will give ten or twelve tons of green weight per acre.

Kafir corn takes the place of sorghum, and to some extent

corn also, in the semi-arid regions. It is grown quite extensively in Texas, Oklahoma, and Kansas. The stalk is used for stover and the ripe grain for feeding animals. The green

25. SORGHUM FOR GREEN FEED
This field made eleven tons per acre of green feed
By courtesy of the Indiana Experiment Station

plant may be used for soiling, but it is not so sweet as sorghum. Milo, durra, and Jerusalem corn are similar to kafir corn.

Canada Field Peas and Oats sown together is a favorite soiling crop. These are sown as early in spring as possible. The peas are usually sown broadcast on top of the ground, at the rate of one and a half bushels per acre. The ground is then plowed about three or four inches deep and harrowed down. The oats are then sown on top either with a drill, or broadcasted and harrowed in. The ground can also be first

prepared and the peas and oats then sown separately. This crop is ready to use in about sixty days from the time of sowing. When the oats are headed and the peas are in blossom, the crop is ready to cut. This mixture also makes excellent hay when dried, especially for cows and sheep.

Indian corn is also a good soiling crop. If the farmer is short of pasture he can use his green corn to good advantage by feeding some each day to his milch cows. Sweet corn is often raised for soiling purposes. It grows quickly and the stalks are sweeter than other corn. Cow-peas and soy-beans may also be used for soiling purposes, especially the cow-peas.

Pastures.—Most farmers depend upon pastures for all of their green feed. Native grasses, like blue grass and the wild grasses of the woodlands, furnish most of the pasturage. Other grasses, like orchard grass, tall oat grass, smooth brome grass, and Italian rye grass also make good pastures, and farmers would do well to cultivate these grasses. Two or more kinds of grasses are usually sown together for pasture. When this is done the ground is better covered, and one kind is likely to grow better at one time of the year than the other, so that more pasture is obtained. In making up a mixture of seeds for a pasture, the clovers should never be left out, especially the alsike and white clover. The white clover never grows big enough to make hay, but always holds its place in pastures.

Rape is a plant that is being grown more every year for sheep and hog pasture. The Dwarf Essex is the variety most commonly grown. Rape will grow on any land that will produce good corn. The soil is prepared the same as for corn, except that the seed-bed must be finer. Rape is sown from early spring to mid-summer. Where small areas are sown, the

seed is sown with a hand drill, in rows about two feet apart. Large fields are always sown broadcast. It takes about two pounds of seed to sow an acre when sowed in rows and about three or four pounds when sown broadcast. When the rape is twelve inches or more tall, pasturing may begin. Sheep and cattle should have some dry feed before they are turned on the rape, else they will eat too greedily and become bloated, which may cause death. Hogs do not bloat, but they should not be turned on when the rape is wet with dew, for the dew irritates and chafes the skin, causing sores. If the rape is not eaten down too close to the ground it will grow up again. It is a good plan to pasture part of the field at a time and let the other grow up again after being eaten off.

Rape is often sown with oats in the spring. The rape plants do not grow much until the oats are cut, then they begin to grow and furnish pasture for the late summer and autumn. Many farmers also sow rape in the corn at the time of last cultivation. Rape grown this way can be pastured off in the autumn with sheep or hogs.

Miscellaneous Forage Crops.—Cabbage and pumpkins are sometimes grown for forage. They are not such good forage as the crops that have been mentioned and are not grown extensively. The crushed canes from mills where sorghum is ground for syrup are frequently fed to live stock. These crushed canes are known as *bagasse*. Sugar beet pulp from beet sugar factories is also much used for feeding animals, especially cattle and sheep.

CHAPTER XIV

OTHER FARM CROPS

Tobacco.—This crop has been grown in America since the days of Jamestown. Tobacco is an American plant. The principal varieties have come from South America, but there is a species which is found wild in Connecticut, New York, and a few other states.

There are many varieties of tobacco, but all are not used for the same purpose. Some varieties are used for cigar wrappers and binders, others for the filling of cigars, others to make chewing tobacco, still others to make smoking or pipe tobacco, and finally some are raised mainly to export.

Tobacco is very greatly influenced by the soil and climate in which it grows. The odor and flavor of the tobacco, as well as the quality of the leaves, are very sensitive to soil and climatic changes. The soils adapted to tobacco growing range from clay loams, loams, and sandy loams to light sandy soils. One who is going to raise tobacco must make a careful study of the subject before he can expect to succeed in any large degree.

The young tobacco plants are started in seed-beds, and after they are of sufficient size they are set out in the fields. The soil in the fields must be thoroughly prepared and well fertilized. Both commercial fertilizers and stable manure are

desirable. The cultivation requires the keeping down of the weeds and a loose mulch of soil on the surface until the plants are too large to cultivate.

When the plants have grown to considerable size they begin to send out blossom buds. These must be removed from all plants except those that are to produce seed for the next crop. When the leaves are ripe the plants are cut and taken to sheds and arranged on racks to cure. At what stage of growth the leaves are ripe is hard to tell in words. It must be learned by experience. After the curing process is done the dried leaves are handled in various ways to prepare them for the market. The method of handling depends upon the use to which the leaves are to be put.

Broom Corn.—Broom corn is closely related to sorghum and looks very much like it. The branches of the heads are longer and usually lighter colored. The stems of broom corn are not sweet like those of sorghum. The head or "brush" is the valuable part of the plant.

Broom corn is raised in nearly every state and territory of the Union, but the total amount produced is not large. Illinois, Kansas, Missouri, Oklahoma, Nebraska, Texas, Iowa, California and Tennessee are the states producing the largest amounts. Three counties in Illinois (Coles, Douglas and Moultrie) produce about one-half of the total crop in the United States.*

There are two kinds of broom corn, the standard and the dwarf. The standard grows quite tall, as much as twelve feet, and has a brush fifteen or more inches long. The dwarf varieties grow about six feet tall and have brushes about twelve inches or more long. The standard varieties are used

* Farmers' Bulletin 174.

for making long brooms, like carpet brooms, while the dwarf varieties are used for whisk brooms and the like.

Any soil that will produce good corn will raise broom corn. The land should be prepared as for corn, but broom corn is not planted so early, for the soil needs to be warmer. The seed is sown in rows about three feet apart, and the plants should stand about three or four inches apart in the row. The sowing is done with special plates in a corn planter or with the wheat drill, the holes not needed being stopped up. It takes about two or three quarts of seed per acre. Cultivation should be given the same as for corn. If the plants are too thick in the row they should be thinned before getting very large.

Broom corn is harvested just as the bloom is falling. The brush gets stiff and brittle if allowed to ripen. For dwarf broom corn the heads are pulled by hand, but the standard has to be "tabled," that is, two rows are broken across each other about three feet from the ground. The heads are then cut off and laid on the broken down stems. The stem left on the brush should be about five or six inches long. As soon as cut or pulled the heads are taken to the drying sheds. Here the seed is removed either by scraping by hand with a curry-comb or by a machine. After the seed is removed the brush is cured. This should be done quickly and without sunshine falling on the brush. It is then baled for market. A good yield of dwarf broom corn is 400 pounds of brush to the acre, and of the standard 600 to 700 pounds. The price runs from about three to four cents per pound. A ton of broom corn will make about 100 dozen brooms of ordinary size.

Flax.—Flax is a fibre crop as well as a seed crop. By *fibre* crop is meant one which furnishes material for making

threads, ropes and cloth. Flax is a very old crop, having been cultivated in early times in Egypt. It is grown throughout the world in temperate climates. Russia is the largest flax-producing country in the world. It produces both seed and fibre. The United States comes next as a seed producer, but not in fibre productions. North Dakota, Minnesota and South Dakota are the largest producers in the United States.

A moist, deep loam soil well drained is best for flax. Land good for corn is also good for flax. The seed-bed should be made quite fine, so that the young plants can get their food quickly. The seed is sown in May. If the farmer wants to get a large crop of seed he sows about two or three pecks of seed per acre; if he wants to get plants good for fibre he sows about one and a half to two bushels. For fibre the stems should be slender and not branched, so they need to stand thickly in the field. The seeding is done by hand or with the drill.

If the crop is raised for the seed it can be cut with a binder when the seeds are well matured, but when grown for fibre the plants are usually pulled by hand, or cut very low with the machine. The harvesting for fibre begins when the straw begins to turn yellow. The pulled stems are stood up in small shocks to cure and the heads are pulled off with coarse combs, or a "header."

The farmer usually does not do more than "head" the flax. He then sells it to the dealer who *rets* it. *Retting* is done by exposing the straw to the sun, dew, and rain for several days until it begins to rot, when the outside skin comes off and the long fibres or threads under the skin can be easily separated. These fibres are made up into linen goods of various kinds. The retting may also be done by immersing in tanks of warm water for a few days.

Flax raised for seed makes about ten to fifteen bushels per acre. The seed is used mostly for making linseed oil. The seed is ground and the oil removed by pressing with heavy presses. This oil is used for paints, linoleum, oil cloth and many other things. The pressed cake is ground up and used to feed cattle and is called oil-cake or linseed meal.

Hemp.—Hemp is another fibre crop. The fibre in the plant is found just under the skin of the stem as in flax. The fibre is obtained by retting just as in case of flax. The fibre is used mostly for making ropes and coarse cloth. Hemp is raised extensively in many parts of the Old World. Kentucky produces three-fourths of all the hemp raised in the United States. A good hemp soil must be deep, loose and well drained. The left-over fertility from crops previously well-manured is better than fresh fertilizer.

The seed is sown with a drill about the same time that oats are sown. About one bushel of seed to the acre is used. It is desirable to get an even stand of plants so that they will all grow up uniformly. The plants are harvested at from eighty to one hundred and forty days after sowing. After cutting they are allowed to dry a few days, then bound or raked into bundles and stacked. Hemp will keep in stacks for two or three years.

Cotton.—Probably the most important fibre plant is cotton. The fibre from the plant consists of the long, fine fibres attached to the seeds and from which so many different useful articles are made. Three-fourths of the world's supply of cotton is raised in twelve states of the United States. Cotton is the chief farm crop in ten of our southern states. One-half of the value of our agricultural exports is made up of cotton. To raise it successfully requires a long growing season,

a high temperature, a well-distributed rainfall during the growing season, and little rain at the ripening period. These desirable conditions are found in the cotton-belt states to a greater extent than in any other part of the world.

Cotton is a very old plant and was grown in the Old World at least five centuries before the time of Christ. Pizarro found the mummies of Peru wrapped in cotton fabrics, and Cortez found the natives of Mexico cultivating the cotton plant.

Cotton belongs to the same family of plants as the hollyhocks and the mallows. It is a strong bushy plant and grows from two to four feet tall. It grows from the seed every year, hence it is an annual. The flowers are white, pale yellow, or cream-colored. They become darker and redder each day until they fall off on the third or fourth day. A little boll is left where the flower was. This develops slowly until mature, when it bursts open and exposes the seeds to which the white fibres are attached. The fibres are called *lint*, and when separated from the seeds they become the cotton of commerce.

There are four kinds of cotton, namely: Sea Island cotton, Upland cotton, Tree cotton, and Indian cotton. 1. The Sea Island cotton is grown along the coasts of South Carolina, Georgia, Florida, and the islands lying near by. The fibres or staple of this cotton are quite long and sell for the highest price. 2. Upland cotton is of two kinds, smooth and hairy. Both of these can be grown on the uplands, but the hairy is the principal one grown in the United States. The smooth has long staple and the hairy has short. 3. Tree cotton grows in India and lives five or six years, growing as tall as twenty feet. It has short, fine fibres and is not much grown. 4. Indian or Bush cotton is also raised mainly in India. It has small pods and few seeds.

The list of varieties of cotton is almost endless. Bulletin 140 of the Alabama Agricultural Experiment Station names and describes over two hundred varieties as being grown in the United States. The cotton plant is greatly influenced by the surroundings of climate and soil, and in this way many varieties arise.

Cotton can be grown on all kinds of soil, but not with equal success. Good tillage is more important in cotton growing than the kind of soil. Land for cotton should be deeply plowed and well fertilized with commercial fertilizers and with leguminous crops. Stable manure should also be used. A good system of rotation should be used, and the rotation should contain one or more leguminous crops. The cotton lands of the South have been carelessly farmed, as a rule, and much of the land has decreased in yielding power. After the land is plowed it is harrowed several times to kill the weeds before planting. The seeds are planted in rows which are about four feet apart and in the row they are dropped so that the plants may stand about twenty inches from each other. The ground must be quite warm before the seeds are planted, for the young plants do not grow well in cool soil. As soon as the plants are large enough cultivation begins, and the aim should be to kill weeds and keep the surface mulched. Shallow cultivation is considered best and is kept up as long as necessary.

Cotton is harvested by picking the seed cotton from the open bolls by hand. By *seed cotton* is meant the seeds and the lint attached. A sack is carried by the picker and into it he throws the seed cotton. Pickers can gather from one hundred to three hundred and fifty pounds per day, one-third of which is lint. The fields have to be gone over several

times, for all the bolls do not ripen at the same time. The picking season lasts about ninety to one hundred days.

After picking, the seed cotton is taken to the cotton-gin, which is a machine for separating the lint from the seed. It consists of a number of circular saws fastened on a wooden cylinder about three-fourths of an inch apart. These revolve in slits less than a quarter of an inch wide, cut in a steel plate. A mass of seed cotton is laid on the plate and as the saws revolve the teeth catch the lint and pull it off the seeds. Under the plate the lint is brushed off the teeth by a revolving brush. By means of a fan the lint is blown through a flue into the lint room where it is baled for market.

The seeds are used for making many different products, the main ones being cotton-seed meal and cotton-seed oil. From the crude oil are made soaps, salad oils, cottolene, and various other articles.

CHAPTER XV

SEED SELECTION

It is important that the farmer plant good seed, for the seed is the foundation of the new crop. Poor seed may not grow at all, or if it does grow, it may give such a poor stand of plants that the crop will not be a paying one. Again, poor seed may bring in many weed seeds, and on most farms there are already too many weeds. Also more seed is required to plant an acre if the seed is not good. This makes an extra expense.

Purity.—In choosing seed it is important that it be free from weed seeds, chaff, sticks and dirt. Some farm crop seeds look very much like some other seeds which are not useful, so that it is easy for dishonest seedsmen to put into the good seed some of these less valuable seeds and sell the mixture to the farmer without the farmer's knowing it. The seeds of yellow trefoil and bur clover look very much like alfalfa seeds, and they are often found in samples of alfalfa seed. The yellow trefoil can also be easily mixed with clover seed. A weed seed known as *buckhorn* is very often found in clover and alfalfa seeds. Small seeds like the clovers and grasses usually contain more weed seeds and mixtures than large seeds, because they are more difficult to get clean in threshing and also because the farmer does not know their

shape and appearance so well as he does large seeds like wheat and oats.

Genuineness.—By genuineness is meant trueness to name. When a farmer buys a certain variety of grain he wants to be sure that he is getting the true variety. The seeds of different varieties of the same grain usually look much alike. For example, one cannot often tell by looking at the grain what variety a sample of wheat or oats is. It very often happens that two varieties get more or less mixed in the threshing, so that the resulting crop from such seed will be still more mixed. Two corn varieties will mix when the pollen from one blows on the other. Sometimes the mixed seed is not objectionable, but it is if the farmer wishes to sell his seed for pure varieties.

Vitality.—By vitality we mean whether or not the seed will grow. The vitality of seed is affected most by its age. It is not safe to plant seeds of our garden crops after they are more than one year old. Most field crop seeds, like corn, wheat, oats, and clover, are good for two years and even longer if they have been carefully stored.

Seed which has been harvested before it is fully ripe is not so good as fully ripe seed. It will germinate more quickly, but the young plants will not be so strong as those from well-ripened seed.

Grain intended for seed should be kept in dry, cool places. It should not be exposed to wide ranges of temperature, or be kept where it is damp at one time and dry at another, as often happens where corn is stored in rail pens or poorly protected cribs. Corn well dried out will stand a temperature of as much as fifteen degrees below zero before the germ will be injured.

In selecting seed one should give attention to its weight, plumpness, and lustre. Heavy seed is best, because it has more material packed in it for the young plant than a light seed. Shrivelled and light seeds should not be used if better can be had. They will probably grow all right, but the plants from them are not likely to be so thrifty. The importance of using the fanning-mill to get the heavy and plump seed can easily be seen. By *lustre* is meant the appearance of the seed, whether it is fresh or dull looking. New seed always has a fresh, shiny appearance, while old seed has lost its freshness. If one compares clover seed three years old with fresh seed the meaning of lustre and its importance are easily understood.

Home-grown Seed.—Crops which have been grown in the same neighborhood for several years have become used to the climate and soil and their seed, if carefully selected, will usually give larger crops than seed brought from a distance. Corn is a crop that cannot be changed very far without bad results. Sometimes if corn is taken but a few miles and planted on different soil it will not give a good crop. Most farm crops do not "run out," as the farmers say, but potatoes and oats, if not carefully selected, do seem to lose in quality and yielding power, in the warmer climates, and new seed from northern places will give a larger crop. If new seed is to be obtained it should be obtained from some northern point, or from a point east or west. It will not do as a rule to bring seed from the south to the north, because it is used to a longer season of growth and will not ripen at the right time.

Testing Seed.—After what has been said above it seems clear that the farmer should use great care in selecting his seed for a new crop. Small seeds like clover and timothy should

be examined for weed seeds and mixtures. Then a number of seeds should be put to germinate on a plate between blotting papers or folds of cloth with another plate covering the top. They should be kept moist and in a temperature of about 70° F. In four days it can be told what seeds will grow. The same plan can be used for wheat and oats, but for corn a larger tester, like that on page 76, should be used. For a method of testing corn see page 76.

The Seed Plat.—By the seed plat is meant a small piece of ground on which the farmer plants extra good seed to get seed for his next year's crop. This is used mostly for seed corn, but should be used for all the farm crops. Many farmers now select choice ears of corn and plant them on a separate plat of ground to which extra care is given. The seed corn for the next crop is then picked from this plat. Such seed gives better yields than seed selected from the general crop. Wheat and oats would produce better if farmers were to sow a half acre or more with choice seed each year and use the resulting crop for sowing the next main crop.

CHAPTER XVI

ROTATIONS

If a farmer raises corn in a certain field one year, and the next year sows the same field in oats, sowing clover with the oats, so that the third year he has clover in the same field, and then in the fourth year he plants the field in corn again and follows it again with the oats and clover, he is raising crops in rotation. A *rotation,* then, is raising two or more crops in such a way that they follow each other in a definite order. If two crops alternate with each other on the same field, a *two-course* rotation is said to be followed. When three crops are used it is a *three-course* rotation, and so on. When a rotation is followed out completely, the farmer has as many fields as he has crops in his rotation, or some multiple of the number.

The farmer raises crops in rotation in order to get the largest returns from his land. Larger total returns will be obtained from a piece of land when it is rotated in corn, wheat and clover, for example, than if corn or wheat is grown every year on the same piece of ground.

A properly selected rotation enables the farmer to keep up the fertility of his land. It does this in several ways. In the first place, while all crops use the same kinds of plant food they do not use them in the same amounts. Corn uses nitrogen, phosphoric acid, and potash, but it does not use so much

phosphoric acid as wheat, and uses more potash. A rotation then keeps the plant food in the soil in balance.

Secondly, plants have different root systems, and so draw their food from the soil differently. Oats and wheat have shallow root systems and get most of their food near the surface. Corn has a large root system and draws from the soil near the surface as well as rather deep down in the soil. Clover and alfalfa have long tap roots and get their food mostly from the deeper layers of soil. By using plants having such differences in their root systems a larger volume of soil is made to furnish food for plants.

Thirdly, a proper rotation always has a legume crop in it. As we have already learned, the legumes leave in the soil more nitrogen than they take out, that is, they gather nitrogen. All other crops, however, use up nitrogen and do not gather any. So it can be seen that, with a proper rotation, the nitrogen supply in the soil can be kept up.

In the fourth place, a rotation enables the farmer to hold in check to some degree injurious insects, troublesome weeds, and some plant diseases. Few of these pests can be completely controlled by rotation systems, but nearly all can be made less harmful. For example, the corn root louse is not often troublesome where a rotation is used; the weed known as ragweed is held in check; and a disease of potatoes known as potato scab is rarely injurious where potatoes are raised on different fields each year.

Besides all the above advantages the rotation method enables the farmer to raise live stock and feed his crops at home. This gives larger quantities of manure for the land, and consequently lessens the need for commercial fertilizers. Furthermore, the rotation system gives work throughout

more of the year than if only one kind of crop were raised. This keeps the farmer employed all the time, and if he has to keep hired help he can engage it by the year, which is better than hiring it by the day.

Notable Rotations.—One of the oldest and most noted systems of rotations is the Norfolk rotation. This was developed in Norfolk County, England, and has been used there for many years. It is a four-course rotation consisting of turnips, barley, clover, and wheat in the order named. If we study this rotation we shall see that it is helpful in the ways mentioned above. It contains a leguminous crop, the clover; it has deep feeding crops, the clover and turnips; it has shallow feeding crops, the barley and wheat; and none of these crops is troubled by the same kind of insects, plant diseases, or weeds as the others.

Another noted rotation is the Terry rotation. It was used by Mr. T. B. Terry, in Ohio, for building up a run-down clay farm. It consists of clover, potatoes, and wheat. In this rotation we have clover as the legume and deep feeding crop, potatoes, which also feed through a large volume of soil, and wheat, which is a shallow feeder.

In the corn-belt states corn, oats or wheat, and clover is a common rotation. In many cases the rotation is corn, oats, wheat, and clover, and sometimes timothy is sown with the clover, and the land is kept in clover and grass for two or more years.

Now, a rotation to be a proper one must be suited to the climate and soil of the region in which it is to be used. It must also be suited to the labor and market conditions. In very few cases could the farmers in the United States use the Norfolk rotation, for the turnips would have to be planted in

rows and cultivated largely by hand, and we could not get laborers enough to manage so many as twenty or twenty-five acres of turnips, nor could we dispose of the turnips after they were raised. There would be no market for them and few farmers would have enough live stock to eat them. The Terry rotation is better. While it would require considerable labor to handle twenty acres of potatoes, yet such a thing is possible, and the clover and wheat can be easily handled. All of these products would find a good market. The corn-belt rotation is most popular, because the crops in it are easily raised, find a ready market, and are well adapted to a wide range of soils. A rotation of cotton, wheat, and clover would not be profitable to farmers in the corn belt states, for the climate is not right, and they could hardly get enough laborers to pick the cotton. There are many kinds of rotations used, but enough has been said to show what things need to be taken into account in the choosing of a rotation.

SECTION III.—HORTICULTURE

CHAPTER XVII

I. POMOLOGY

BEFORE going further we need to know the difference between horticulture and agriculture. Professor Bailey says that "*agriculture* in its largest meaning is the raising of products from the land." However, "agriculture is usually limited to the growing of grain, forage, bread-stuffs, textiles, and the like, and to the raising of animals. *Horticulture* is the growing of flowers, fruits and vegetables, and of plants for ornament or fancy." We see from these definitions that what we have been saying about soils and crops and what we shall say about animals and dairying is to be considered under agriculture, while what we are now to say about fruits, vegetables, and flowers refers to horticulture.

Horticulture is of two kinds: that which is concerned with growing such fruits, vegetables, flowers and shrubs as almost every farmer will want on his farm and that which is concerned with the growing of certain kinds of fruits, etc., on a large scale, that is, for market purposes. Professor Bailey divides horticulture into four main divisions: * 1. Pomology, which means the growing of fruits. 2. Olericulture, the growing of vegetables. 3. Floriculture, the raising of ornamental plants for their individual uses or products. 4. Land-

* *Cyclopedia of Horticulture*, topic Horticulture.

scape Horticulture, or the growing of plants for their use in the landscape. These terms will be explained more fully as each is taken up. For our purpose the last two will be considered under one head, that of landscape gardening.

Pomology is the term used to cover the growing of all kinds of fruit. Now fruits may be classed as tree fruits, like apples and cherries; vine fruits, like grapes; and small fruits, like raspberries and strawberries. Instead of the term pomology we shall use the more common name—fruit-growing. We shall first speak in a general way of the location of orchards and fruit gardens.

The orchard and fruit garden should be planted on sloping land whenever possible. A hillside with a stream along its foot is a very desirable place to plant fruits. A hillside is a good place because it allows air-drainage. By *air-drainage* we mean that air will have a tendency to settle to the lower ground and move off down the valley. It is a known fact that it gets colder in the valleys and low places than it does on the hillsides. Frosts and fogs occur in the valley before they do on the hilltops. So trees and bushes planted on a hillside are less likely to be injured by frosts and the cold of winter than if they were planted in the low places. It takes only a few feet of a rise in the land to make a good deal of difference in the temperature. Furthermore, it is not desirable to have the orchard surrounded by a thick growth of forest trees, as it hinders the movement of the air.

The direction in which the land slopes is an important item. A north or north-west slope is good for apples, pears, plums, and cherries, but not for peaches and grapes. However, fruits with the most brilliant colors are raised on southern slopes. While it is not necessary to have wind-breaks to

protect against the cold, it has been found that a wind-break on the windy and sunny side is helpful in preventing the blowing off of the fruit and in protecting against hot winds. The air on a northern slope is cooler than that on the southern slope. This is desirable in spring because the buds and blossoms will not start so soon and will thus probably escape the frosts that usually follow a warm spell. Some people cover the ground around their trees with straw or manure when the ground is frozen, so that it will not thaw out quickly in spring and the blossoms thus be held back. Such covering does no good, for the starting of the buds is influenced by the temperature of the air. If the end of a grape-vine or peach-limb be pulled into a warm room through a hole in the window, it will put out buds in a short time, although the roots of the vine or tree are frozen solid in the ground.

Fruits can be grown on almost any kind of soil. There is little excuse for a farmer to be without fruit because his soil is not right. Of course each kind of fruit does like a certain kind of soil better than another. We shall speak of these as we take up the individual fruits. In general all fruits and ornamental trees and shrubs do best on a good soil having a porous subsoil, that is, one that permits the surplus water to drain away and allows the roots to grow downward easily. Such a soil does not get so dry in dry weather nor so wet in wet weather as one having a compact subsoil. If one is raising fruit in a large way for market, he should select land which is naturally well adapted, but drainage, irrigation, or fertilization, as the case may require, will usually give adequate returns.

CHAPTER XVIII

PROPAGATION OF THE FRUITS

THE number of plants of any of the fruits can be increased in one or more of four different ways, namely, from seeds, by layering, by cuttings, and by grafting.

Planting the *seeds* of a desirable variety in order to get more of that variety is not very satisfactory, because usually the new trees or bushes will not bear the same kind of fruit as the one from which the seed came. For example, if we were to plant the seeds from a Baldwin apple the young trees from those seeds would not bear Baldwin apples, because the blossom which produced the Baldwin apple was probably fertilized with pollen from the blossoms of a different kind of apple. The seeds in the new apple will produce trees which will have some of the qualities of both kinds of apples. When one smells a dandelion blossom he gets some yellow dust in his nose; this is *pollen.* When pollen is carried from one flower to another the second flower is said to be fertilized by the first. The bees and the wind are active agents in carrying pollen. The seeds from plums, grapes, gooseberries, strawberries, and all other fruits act in the same way as those from apples.

Layering is a common method of getting new plants of black-cap raspberries, dewberries, and strawberries. In layering the plants are covered with soil at the ends or at the

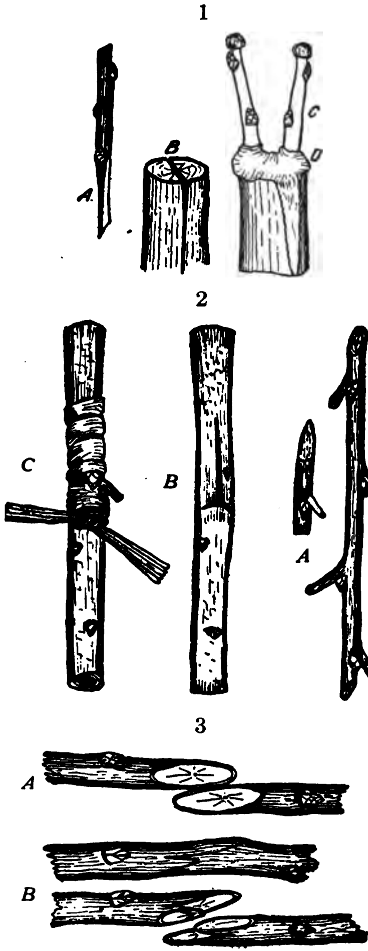
joints. New canes come up from around the base of the old plants of raspberries and dewberries and grow quite rapidly. They soon bend over and the tips after a while touch the ground. These tips often take root of their own accord, but they can be helped by having a shovelful of dirt thrown on them. In fall or the following spring, the new plants can be cut loose from the parent stems. Strawberries send out runners, which take root without any help and thus make many new plants. Grapes can also be increased by layering. Vines of the previous year's growth are best. They are laid down in the spring and covered three or four inches deep. New plants start from almost every bud. In the fall these layers should be lifted and the new plants cut loose from each other.

A *cutting* is a part of the parent plant cut off and stuck in the moist ground, where it takes root and produces a new plant. For fruits two kinds of cuttings are used—roots and stems. Cuttings are used mainly for blackberries, grapes, currants, and gooseberries. The roots of blackberries are used—roots a quarter-inch or more in diameter. They are dug up in the autumn, cut into pieces a couple of inches long, and stored in dry sand in the cellar until spring. When the ground is warm these cuttings are planted two or three inches deep in good soil. They soon begin to grow and make good plants. For grapes, currants, and gooseberries the new growth of stem is cut in the autumn and stored in dry sand the same as blackberry roots, or they may be planted at once in the fall. When stored in sand the cut end callouses, or heals, over, and this is probably better than to plant the fresh cutting. Early in spring the cuttings are stuck or planted in the ground. They are usually eight or ten inches long, but may be shorter. Every cutting must have at

least two buds on it. One is covered up in the ground to make roots, the other is left exposed to grow into a new stem. Where plants are raised in large numbers, cuttings of all kinds are usually started into growth in hot-house beds.

By *grafting* is meant the taking of a part of a plant and fastening it on another plant in such a way that the two become firmly united by growth. The part which is taken is called the *scion* (sometimes it is just a bud) and the part or plant to which it is grafted is called the *stock*. The tree fruits are the ones usually grafted. Nearly all the fruit trees bought from the nurseries have been grafted. The nurseryman sows the seeds of trees, and when the young trees, called seedlings, are large enough the variety which he wants to increase is grafted on the roots. A fruit is not always grafted on the same kind of stock. For example, pears may be grafted on quinces, apples on crab-apples, peaches on plums. Very often, however, a variety is grafted on another variety of the same kind, but one which is hardier and less useful. This is usually done with peaches, plums, and cherries.

There are many ways of grafting. They can be classified in three groups: budding, scion-grafting, and in-arching. *Budding* is very extensively used for peaches and cherries. In budding two slits are made on the stock through the bark to the wood with a sharp knife and the bark loosened a little next the slits. One of the slits is made up and down and the other crosswise. A bud cut from a branch of the desired variety is slipped into the slits and the bark bound down to the bud by wrapping with a narrow piece of muslin; nurserymen use raffia. In cutting the bud just a small amount of the surrounding bark is left attached and the cut is made deep enough to take a very little of the wood just under the



26. METHODS OF GRAFTING

1. Cleft-grafting
   A. Scion. *B*. Cleft. *C* and *D* Scion in place and waxed
2. Budding
   A. Bud. *B*. Slit in stock. *C*. Bud in place and tied
3. Whip or splice-grafting
   A. Scion and stock without tongues. *B*. Scion and stock with tongues

By courtesy of the Pennsylvania Department of Agriculture

bud. Budding is usually done during the growing season, either summer or fall, but it is sometimes done in the spring. It is always done on young trees. The next spring after budding, the part of the stock above the bud is cut away.

In *scion-grafting* a scion, or twig, containing one or more buds is fastened to the stock in such a way that the green-colored tissue under the bark of each comes in contact on at least one side. The scions are cut from the previous season's growth in the fall or winter, or even in the spring before growth starts. These scions are kept in sand or moss in a cool place until wanted. When the stock used is a root, the process is called root-grafting; when the graft is made just at the surface of the ground it is called crown-grafting; when on the trunk just below the limbs, stem-grafting; and when on the branches, top-grafting.

There are two principal ways of grafting with scions: *whip-grafting* and *cleft-grafting*. In the first the stock and the scion are each cut to a long one-sided wedge shape. A tongue is cut in each wedge by splitting slightly with the knife. The two cut surfaces are brought together and the tongues slipped into each other. The green wood of the two must come together on at least one side. The scion and the graft are now wrapped tightly with waxed cord. This method is used almost entirely in root and crown-grafting and also in stem-grafting when the stem is small. Sometimes the scion and the stock are cut in the wedge shape and brought together without cutting the tongues. Such a connection is called a splice-graft. If the whip or splice-graft stands outside the ground, it must be covered with wax. (See cleft-grafting.)

The second method, or *cleft-grafting*, is used with large stems and branches. The stem or branch is sawed off

straight and then split slightly with a knife or thin-bladed instrument (nurserymen have special tools). The scion is cut to a two-sided wedge shape and pushed into the split in the stock. The scion is always much smaller than the stock and care must be taken that the green bark of one comes in contact with the other. A cleft-graft does not need to be bound with raffia or twine, because the stock is strong enough to hold the scion firmly. However, the split part and all about the scion must be covered with grafting wax to keep out the water. When the branch or stem to be grafted is a large one, two scions are generally put in, one on each side.

A good *grafting wax* can be made by melting together three parts of resin, three parts of beeswax, and two parts of tallow. When cool it can be applied with a small paddle or old knife. This wax should be used on all large wounds, because they do not heal until the new growth grows over the cut ends from the green part of the bark. If wounds are left uncovered they are apt to begin decaying and thus weaken the tree or limb.

In-arching is a method of grafting two plants which stand near each other. Each plant remains growing on its own root until the joined parts have grown together. To in-arch two plants it is only necessary to cut away the bark where they come together and tie them firmly with raffia or narrow strips of cloth. If the plants joined are woody plants, the parts should be covered with wax. In-arching is practised mostly with soft-wooded and herbaceous plants. When the parts have grown together, the scion is cut loose from its root and the process is done.

The methods of grafting and increasing plants described in this chapter are modified in many ways by nurserymen and fruit growers, but the principle is always the same.

CHAPTER XIX

TILLAGE

LAND which has been planted in fruit should be cultivated in much the same way as land planted to other crops. Of course before the fruit has been set out the land has been deeply plowed and thoroughly prepared. For several years after trees have been set out, the land can be cultivated in such crops as corn and potatoes. These are called *hoed* crops, because we try to keep down all weeds by cultivation. Such crops as wheat, oats, and timothy should not be raised in an orchard. They choke the trees too much. Cultivating in the orchard has the same effect as it has in other fields. It saves moisture, kills weeds, and makes plant food available. Whatever kind of fertilizer is applied to the crop is also helpful to the trees. Potatoes are one of the best crops to raise in a small orchard, because they occupy the ground only a couple of months during the summer. The tops of the potatoes shade the ground well, but the tops of the trees are not shaded and crowded as they are when corn is grown in the orchard. Potatoes can be dug early in the fall and with a harrow the ground can be put in shape for the sowing of a cover or mulching crop, such as rye, crimson clover, or cow-peas. It is quite desirable to have some covering on the ground during the autumn and winter, for the crop prevents a loss of the available plant food by using it in growing. Furthermore,

the covering has a tendency to hold water and let it soak into the soil, thus storing it up for the next season as well as keeping the land from washing. The covering also prevents the evaporation of moisture early in the spring, and when it is turned under it adds humus to the soil, which we have learned is useful.

27. A BASKET OF FINE PEACHES

The large size and uniformity were secured by judicious thinning

By courtesy of Ohio Experiment Station

Where the land is planted to vines and small fruits it will not be desirable to try to grow any kind of crop between the rows, but the plants themselves are cultivated all through the growing season, except during the season of fruiting. Cover or mulching crops, however, are desirable for winter protection.

Many fruit growers after their trees have become large enough to produce fruit, stop cultivating and let the land become set in grass. Other growers keep their orchards bare and do not let anything grow under or between the trees. Growers of fruit should not forget to fertilize and manure their trees. Too many farmers believe that a fruit tree does not need any manure or fertilizer. A load of stable manure

spread around an old apple tree that no longer bears good fruit will make a great difference within a year. Stable manure is always good to spread on orchard land. It adds plant food and humus to the soil. In addition, phosphoric acid and potash fertilizers are very helpful. Good cultivation and heavy fertilizing will give large returns in fruit of large size, brilliancy of color and fineness of flavor.

CHAPTER XX

SETTING THE ORCHARD AND CARING FOR IT

After a site has been chosen and the land prepared, the next thing in order is to lay out the field in a definite plan and set the trees. However, before this is done there must have been some attention given to the kinds of fruit, the varieties and the selection of trees. For family use there ought to be a few trees of all kinds of fruit that will grow in the locality. There ought to be, if it is possible to grow them, apples, pears, peaches, plums, and cherries. Where fruit is grown only for the use of the family not many trees of any one kind will be needed, but two or more trees of each kind will afford a variety of tree fruits as well as give fruit at different times of the season. In the selection of varieties, the farmer or grower needs to take into account the tastes of the family, the adaptation of the varieties to the climate, their yielding power, and their time of ripening fruit. If care is given to this last point, there can be fresh ripe fruit for use nearly the entire summer.

Where a grower is raising fruit for market, he will usually raise only one or two kinds of fruit, and only a few varieties of these kinds. He will choose such kinds and varieties as sell well on the market and by reason of their handsome appearance and good quality bring big prices. He will also want varieties that are large yielders. To the grower raising fruit for home use only, the quality of the fruit is important.

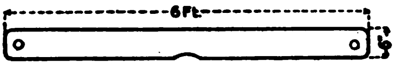
He wants good flavor rather than size and handsome appearance.

It is best to get trees from a home nursery if such is to be found. The buyer can go there after his trees and will be more certain of getting the varieties which he wants. He can also select the size of trees desired. Trees obtained from a home nursery will be better adapted to the climate than those obtained from a distance. If no home nursery is to be reached, one must buy from nurseries at a distance. The most reliable rather than the cheapest one should be patronized. It is best to buy northern grown trees. Trees one or two years old are to be preferred. They do not yet have very large tops and the grower can shape the tops to suit. Young trees suffer less in the transplanting and begin growing almost as though they had not been moved. Trees four or five years old will lose a year or more in recovering from the set-back due to cutting off so many roots and so much top as is necessary in moving them.

Having selected the trees it is best to have them dug early in the spring before growth begins and brought to the place where they are to be transplanted. Here they should be heeled in until time to reset. By *heeling in* is meant the covering of the roots of the young trees as they are bound together in the bunch. One digs a shallow hole and puts in the entire bunch of roots and covers them with soil. When buds have begun to start on other fruit trees, the heeled-in trees can be dug out and reset. It will be noticed that the cut ends of the roots have begun to heal, or callous, over and young roots have started. This condition is desirable, and such trees will grow better than trees freshly dug and reset.

In setting out trees in the houseyard or around buildings,

no attention is given to getting them in straight lines, but when an orchard is to be set out care is usually taken to have the trees in straight rows. To do this requires careful measuring and the setting of a stake where each tree is to stand. Even after this is done it is difficult to dig the hole and set the tree so that it will stand exactly where the stake stood. "The only method by which this can be done is by having a stake set wherever a tree is to stand, then have a board about six inches wide and six feet long (as shown in Fig. 28). Cut a notch in one side at the middle just about large enough



28. A PLANTING BOARD
An easy device for setting trees in line

for the stem of the tree, bore a hole in each end exactly the same distance from the middle notch. Then, whenever a tree is to be planted, place the board on the ground with the notch around the stake and stick two other pegs through the holes in the ends, remove the board, leaving the two pins remaining, dig the hole, replace the board and set the tree with the stem in the notch."* Such a board as described above is called a *planting board* and is very helpful.

The distance apart to set trees is important. Trees which grow large and live many years should be set far apart. Trees which have small tops when grown and which do not live many years can be set quite close. In setting large orchards care should be taken that there is room enough between trees so that teams and wagons can be driven between them when gathering the fruit, spraying the trees, or

* Bulletin 152, Department of Agriculture, Pennsylvania.

cultivating the ground. Apple trees should stand about 35 or 40 feet apart in the rows, pears 20 feet (dwarf pears 10 feet), peaches, plums, and cherries 16 to 20 feet, and quinces about 12 feet. In planting an apple orchard many growers plant peaches, pears, or cherries between the apple trees, because the apple grows slowly and does not begin to bear fruit for several years, whereas the peaches, pears, and cherries begin to bear fruit in two or three years. As the apple trees become larger the other fruit trees can be cut out. In this way the orchard is made to pay returns almost at once, but such practice is often bad for the apple trees, because it crowds them and robs them of their food. Then, too, the grower does not like to cut out a peach, pear, or cherry tree that is thrifty and bearing lots of fruit.

In transplanting, care should be taken to set the young tree properly. Usually it is leaned a little toward the direction from which the wind generally comes. This is to prevent it from being blown in the opposite direction. As it becomes older it will usually stand straight. If the roots have been badly torn and bruised in digging from the nursery row, the torn ends should be cut off. The wounds will then soon callous, or heal over, and young roots quickly start. Where trees have been "heeled in" this trimming should have been done before the heeling in. The loose soil should be carefully filled in around the roots and pressed down with the foot. The surface should be left loose to act as a mulch. If there is any sod, it should be turned upside down in the hole. It is usually not necessary to pour water around the tree when transplanting. If watering is done after transplanting the ground should be thoroughly soaked, for a slight watering does more harm than good. After the tree is set it will be necessary to prune the

top, because in digging up the young trees probably more than half of the roots were left in the ground. There will not be enough roots, therefore, to supply food and moisture for the large number of leaves that will come on the top if it is left unpruned. The top should be cut back more than the roots have been reduced. Some growers cut off all the branches and leave the young tree as a single straight stem; others cut the branches back a good deal, depending upon the age of the tree. The first method is probably better for peaches and the last better for the other tree fruits. In the last method the *head,* or *top,* is started at once, while by the first, one waits until the second year to start the head.

The head is started at various distances from the ground, depending upon the climate. In cold climates the head is formed so that the lower branches are only two or three feet from the ground, while in warmer regions it may be much higher. The low head is more convenient when the fruit is to be picked, but the high heads are more easily worked around in cultivating. In shaping the head of the tree care should be taken not to have two limbs starting from the same place on the stem. Such a condition forms a *crotch* and when the tree is heavy with fruit, the limbs are apt to split apart there.

After the head is started the young trees should be pruned carefully each year. Usually not much will have to be cut off at one time. Such limbs as will not give the shape desired should be removed, and when there are too many limbs some must be cut out. If the tree is growing too fast the longer limbs are cut back. This is called *heading in* and is much practised by some who wish to keep the heads of their trees small and compact. Usually, however, care should be taken that the heads do not become too thick. Limbs should be

cut out until the head is rather open. This gives admission to air and sunlight and permits the fruit on the inside of the top to ripen at the same time as the outer fruit and also be well colored.

Sometimes when trees begin to bear fruit the grower discovers that the fruit is not the kind that he wants. In such cases, if he wishes, the grower can *top-graft* his trees with the varieties which he desires. In top-grafting the top is cut back severely and small scions are introduced into all the larger limbs. The small limbs are cut off entirely, and limbs having a diameter of one inch or more are used for the stocks. Top-grafting is hard on the tree because so many wounds are made, but the tree usually recovers and bears fruit from the grafts.

Orchards which have never been cared for can usually be made to bear good fruit rather easily. Such trees should be pruned sensibly, washed, scraped, and sprayed. Too many limbs should not be cut out at once. The trunks should be washed with strong soap suds, using a stiff brush. Before washing it is well to scrape the old bark and moss from the large limbs and the trunk with a hoe. The whole tree should be sprayed with Bordeaux mixture. (See Chapter XXIX.) The spraying and washing will soak up the bark so that the tree can grow well. The spraying and washing also kill insects and fungus diseases. Such treatment of old orchards is called *renovating*.

CHAPTER XXI

THE FRUITS

THE tree fruits may be divided into pome and stone fruits.

1. Pome Fruits.—The apple, pear, and quince are called *pomes,* because they contain a core in which are the seeds.

The Apple.—The apple is one of the oldest cultivated fruits in the temperate zone. It originated in Eastern Europe and Western Asia. Some varieties of the crab-apple came from European or Siberian ancestry, while others came from our native American wild crab-apple, or from crosses of it and the European crab-apple.

When fine, large apples are desired thinning should be practised. This is done by pulling off some of the young apples when they are as large as small nuts. Thinning is tedious work, but will pay well in fine fruit.

Apple varieties are classed as summer, autumn, and winter sorts. There are many good varieties of each kind—more than we can attempt to name here. Yellow Transparent, Early Harvest, Red Astrachan, Duchess, and Benoni are good summer varieties. For autumn use the Maiden Blush, Wealthy, Rambo, Fall Pippin, Bellflower, and Grimes' Golden are excellent. Rome Beauty, Ben Davis, Smith's Cider, Tulpehocken, and Winesap are good keepers for winter use. All varieties are greatly influenced by conditions of soil and climate, and a variety which is popular in one section may not be at all satisfactory in some other place.

29. A SCENE IN AN INDIANA APPLE ORCHARD

One hundred and seventy acres are set in apples, principally Yellow Transparent, Grimes' Golden, Rome Beauty, Jonathan, Winesap, and Genet

By courtesy of the Indiana Horticultural Society

Some good varieties of crab-apples are Transcendent, Siberian, and Hyslop.

The Pear.—The pear was probably first cultivated in Asia, although there is reason to believe that many varieties first came into use in Europe. It is said that the best soil for pears is "a strong loam of moderate depth with a dry subsoil." * Pears are dwarfed, that is, made to grow small tops, by being grafted on quince roots. But even when so grafted the top has to be trimmed back considerably to keep it from growing too large. To get fine fruit, pears should be thinned so that the young pears hang from four to six inches from each other. The flavor of pears is improved if they are picked before fully ripe and placed in a cool, dry place on the floor or on shelves and allowed to ripen slowly. Air currents should not blow over them. Pears to be kept for winter use should be put into barrels or boxes and kept in a cool place. The time to pick is when the fruit will separate easily from the twig. Some varieties of pears cannot fertilize their own blossoms and must be planted with such varieties as are self-fertile.

The Anjou, Bartlett, Clapp's Favorite, and Lawrence are good varieties, but cannot fertilize themselves. They should be planted with some of the following, also good varieties: Flemish Beauty, Keiffer, Le Conte, Seckel, and Angouleme.

The Quince.—This fruit is found growing wild both in Europe and in Asia. In the United States the quince is grown mostly east and south-east of the Great Lakes. It is used mostly for jellies and preserves. It requires rich, moist soil to give the best crops. It is usually allowed to grow up as a bush, having a number of stems from the base. It can also be pruned into a tree. The fruit is usually not picked

* Downing.

until it has been frosted a couple of times, although some pick the fruit when yet green and ripen it in a cool, dark room.

Two of the best varieties are the Orange and Champion. A variety known as the Japanese quince is used entirely for ornamental purposes. It has beautiful, showy red flowers. The fruit is useless and is small both in size and quantity.

2. **Stone Fruits.**—The cherry, plum, peach, prune, and apricot are called *stone* fruits, because the seed is enclosed in a hard, stony shell.

The Cherry.—This fruit came from Asia. There are two kinds of cherries, sweet and sour. The sweet cherry is often called the *heart* cherry. With the sweet cherry the blossoms appear with the leaves, while with the sour cherry the blossoms come first. Sweet cherries do not stand transplanting well, many of the trees dying. It is better to plant seeds where trees are to grow and then bud with buds from trees which have been good producers of fruit. The sour cherries are easily transplanted. Cherries will grow on almost any soil not too wet, but a well-drained, light loam soil is best. The head of the cherry tree should be started near the ground in order to make it easy to pick the fruit and also to protect the stem of the tree from the hot sun, which often scalds or burns the bark, sometimes killing the tree. Trees do not need much pruning after they begin to bear.

Some of the best sour varieties are the Early Richmond, Dyehouse, English Morello, and Montmorency. Of sweet cherries the Governor Wood, Windsor, and Black Tartarian are among the best varieties.

The Plum.—The plum is native to America, Europe, and Asia. Many good varieties have come from each of these countries. The central states are as well adapted as any

place in the world to the growing of plums. Plums are usually started from the seeds and then budded. It is best to bud in damp weather, and the bud is usually placed on the north side. Scion grafting is also practised, but must be done in early spring. Plums grow in all kinds of soil and differ somewhat according to variety, but best crops are obtained on heavy loams or clays. Two or three varieties should be planted together so that the blossoms will fertilize each other. The fruit should be thinned so that no two plums touch each other. Some of the best varieties of plums are: Wild Goose, Robinson, Bradshaw, Lombard, Green Gage, Abundance, Blue Damson, Burbank, Red June, and Satsuma.

The prune is a plum, firmer and not quite so juicy as ordinary plums. It is usually dried before being put on the market. The Fellenberg, York State, and German prune are among the best prune varieties.

The Peach.—The peach is more largely sold on the market than any other stone fruit. Because of the ease with which they may be grown almost every farmhouse has a number of peach trees about it. Peaches first came from Persia. They are not able to stand the cold winters of northern regions, but nearly all the states in the Union produce some peaches, while Michigan, Long Island, Maryland, Georgia, Alabama, and California are famous for them.

A rich, sandy loam soil is best for peaches. Heavy soils are to be avoided, if possible. The soil usually has an influence over the flavor. Young trees are started from seeds sown in autumn. The next spring they come up and are large enough to be budded in August. Grafting is hardly ever practised, because the cuts do not heal quickly. In getting buds for budding, select from trees which have borne fruit. Care

should be taken not to select fruit buds, but leaf buds. Trees should be carefully pruned while young, and when they begin to bear they will not need much pruning. Cutting back about one-third of the new growth each year is enough. The peaches are always borne on the growth of the previous year. To get fine fruit, peaches should be thinned so that they are three or four inches apart on the twigs.

Varieties of peaches may be classed as free-stones and cling-stones, that is, in one the flesh comes loose from the seed easily when ripe, while in the other the flesh clings closely to the seed and has to be cut away. The flesh may be white, yellow, or red blushed in either class. Some of the good varieties are as follows: free-stones, Old Mixon Free, Champion, Stump, Elberta (most widely planted of all varieties), and Early and Late Crawfords; cling-stones, Carmen, Heath Cling, Sneed, and Steady's Cling.

The Apricot.—This fruit resembles both the plum and the peach. It comes into blossom quite early in spring before any other fruit tree and is often frosted so that no fruit is produced. It is cared for the same as the peach. The Large Early and Moorpark are considered good varieties.

The *Nectarine* is a kind of peach. The seeds from it sometimes produce peaches and sometimes nectarines.

3. **Vine Fruits.**—*The Grape.*—The grape is our only vine fruit. Grapes are more largely used as a fruit in the United States than in any other part of the world, although their culture was known in Europe and Asia centuries before America was discovered. Most of our grape varieties have been developed from our native wild varieties. The wild fox grape has furnished most of the varieties grown in the northern and eastern states; the summer grape those for the

southern states; and the wild grape of the river banks the varieties for the western and south-western states. On the Pacific coast most of the varieties are of European origin. It is here that the raisin grapes are raised.

Grapes will grow in any well-drained soil, but best in a dark-colored loam not too fertile. Grapes are usually propagated by cuttings or by layering. Commercial growers keep the young vines closely pruned back until they are four years old and then let them bear only a few bunches of fruit. The farmer usually does not cut back his vines so much. The commercial grower trains his vines to grow on a trellis, or a stake. The farmer lets his vines run along the side of a building or on a roof and sometimes over an archway to make shade as well as fruit. Finer fruit will be obtained if not too many clusters are allowed to grow on a vine. It is best for the vine to cut it back heavily every year, leaving only one or two buds on a branch and not many branches on a main stem. Pruning is best done in the autumn or very early in spring. If the vine is pruned in the spring the sap is apt to ooze from the cut end ("bleed") and weaken the vine.

The varieties are classed as purple, red, and white. Of the purple ones, Moore's Early, Worden, and Concord are good; of the red, Brighton, Salem, and Delaware; and of the white, Diamond, Niagara, and Martha.

4. **Small Fruits.**—Of the small fruits the currant, gooseberry, raspberry, blackberry, and dewberry, are commonly called *bush* fruits from their habit of growth.

The Currant.—All our good varieties of currants have been brought from Europe or developed from European varieties. The currant naturally likes cool conditions and so does best in a rather compact soil. However, the soil should be fertile

and it is well to manure the currant heavily. It is good practice to mulch around currant bushes with straw, rotted sawdust, or coarse manure. The mulching keeps the soil moist and cool. New plants are obtained easily by planting cuttings. These can be made in August from the shoots of the same year's growth. These cuttings should be about six inches long. They are stuck in the ground until only the top end is exposed. They will take root the same fall. Currants do not need much pruning, except to keep the bushes from getting too thick and having too many old stems. The currants are produced on stems which are one year old or more. Stems older than three years ought to be removed.

The best varieties are the Pomona, Red Dutch, Wilder, Fay, White Grape, and White Dutch. The last two are white in color and are used for dessert purposes mainly.

The Gooseberry.—Most of our gooseberry varieties are of American origin. There are some good varieties from Western Europe and England, but they are more likely to be attacked by mildew, a kind of plant disease, than our American sorts. New plants are obtained by cuttings and from layering. It is better to plant the cuttings very early in spring after keeping them buried in a dry place out of doors all winter. Otherwise they are cared for just as currants.

Some of the best American varieties are Downing, Champion, Houghton, Pearl, and Smith. Of the European the Industry, Chautauqua, and Portage are fairly good.

The Raspberry.—There are two principal kinds of raspberries: the blackcap and the red. There are also yellowish-colored raspberries. These are "sports" from the red varieties. A *sport* is an oddity—an accident. No one has been able as yet to explain just what causes "sports."

The blackcap varieties mostly have black-colored berries and are native Americans. They grow best on sandy or clay loam soils that are rich, moist, and well-drained. Plenty of humus in the soil is desirable because it holds moisture. Success with any kind of berries depends upon having the soil moist at fruiting time. Plenty of stable manure is a good fertilizer for blackcap varieties. The plants are increased by the tips of the new canes taking root at the ends. The berries are borne on canes one year old. As soon as the berries are ripe these canes die and should be removed. To keep new canes from getting too tall they should be pinched off at the tips when two or three feet high. This will cause them to send out many side branches which will also have to be pinched back when they are ten or twelve inches long. Such treatment makes strong, sturdy plants. New plants should be set in the spring and the old canes attached to them should be cut off near the ground so that no berries will be produced the first year.

The red raspberries are of two kinds which are much alike. One is of American origin and the other is from Europe. The red varieties do not take root at the tip of the canes, but send up many suckers from their roots. New plants can also be produced from root cuttings. The red varieties are better when not pinched back during the summer, but should be cut back to a height of three or four feet the next spring. Red raspberries grow on about the same soil as the blackcaps.

Some good varieties of the blackcaps are Gregg, Kansas, Black Diamond, Nemeha, and Conrath. Of the red varieties the Cuthbert, Loudon, Miller, and Marlboro are good. The Golden Queen is a good yellow variety.

The Blackberry.—This fruit is cultivated only in America. Our varieties are all American. The soil and treatment for blackberries is almost entirely the same as for raspberries. In pruning new canes it is well to wait until the blossom-buds appear in the spring, otherwise the crop may be cut short by pruning off the very parts which would produce fruit. The old canes, of course, are removed in autumn. Early varieties are to be preferred on account of danger that dry weather will cut the crop short. Some of the best varieties are Snider, Erie, Agawam, Eldorado, and Ancient Briton.

The Dewberry.—The fruit and plant of the dewberry look very much like the blackberry. The plants have a trailing habit of growth. There are few flowers in a cluster and the middle one opens first, while in a blackberry the outer flowers open first. Dewberries ripen their fruit earlier in the season than do blackberries. Dewberries increase their plants by taking root at the tips of the canes; blackberries produce new plants from suckers or root cuttings.

The Lucretia is about the best variety. The Windom, Mayes, and Bartel are also good in certain sections.

The Strawberry.—The strawberry is a small fruit in a class by itself. It is found wild in Europe, in North America, and in South America. Our cultivated varieties are derived from the mixing of varieties from all three sources. Strawberries will grow on any good soil. It should be deeply plowed and worked down to a firm seed-bed. Autumn plowing is best. Leave the soil rough and harrow it in spring. The plants should be set early in spring and should not be allowed to bear fruit the first year. In selecting plants, only young ones should be used. Young plants always have bright yellow roots. They are usually planted in rows. For large patches

the rows are three or four feet apart and the plants eighteen inches apart in the row. For a small patch they may be closer set. The plants should be cultivated during the summer and runners should not be allowed to grow until July. The plant will in this way be stronger.

Some varieties of strawberries do not produce any stamens, but only pistils. Such varieties are called *pistillate;* other varieties have both stamens and pistils and are said to be *perfect.* In planting a patch of strawberries it is necessary to mix the pistillate and perfect varieties, or else the pistillate varieties will not get fertilized and cannot produce fruit. As soon as a crop of berries is harvested it is a good plan to mow off the leaves and as soon as they are dry burn them. This destroys many insects and weeds and the new growth of leaves will be all the more thrifty. A patch should not bear more than two years before being plowed up.

There are many good varieties. Warfield, Bubach, and Haverland are pistillate. Clyde, Gandy, Jesse, Bederwood, Cumberland, Parker Earle, and Sharpless are good perfect varieties.

CHAPTER XXII

II. OLERICULTURE OR VEGETABLE GROWING

PLANNING AND PREPARING THE VEGETABLE GARDEN

BEFORE beginning this discussion of our subject it will be necessary to make clear what is meant by vegetables. In the scientific sense all plants are vegetables, because all plant life belongs to the vegetable kingdom. We say, also, when speaking scientifically, that whatever results from a blossom is a fruit, whether it be an apple, a pepper, a tomato, a walnut, or a cone from a pine tree. But in common usage, practically everything which is raised in the garden or truck patch, except the small fruits, is called a vegetable. Hence, we call tomatoes, peppers, potatoes, cabbages, peas, sweet corn, pumpkins, and all such, vegetables.

Every farm has its garden and truck patch. Usually the two are separate. In the garden are usually grown a few of the smaller and earlier vegetables like radishes, onions, beans and peas, along with some small fruits. In the truck patch are grown potatoes, tomatoes, sweet corn, cucumbers and the like. The labor in the garden is done by hand; in the truck patch largely with a horse.

Now it will be a saving of time and labor if the garden and truck patch are combined into one and so arranged that the labor can be done by a horse and horse-tools. Such a garden should be laid out with long rows, so that there will not need

to be much turning in preparing and cultivating the ground. It is not necessary that every row be complete with only one kind of vegetable. Several kinds can be planted in the same row. If bush fruits are grown in the garden, they should occupy one side of it so as to be out of the way as much as possible. Such plants as hold their places for several years, like asparagus and rhubarb, should also be put at one side. If only annuals are raised the garden can have a place in the corn field nearest the house, but this is usually not satisfactory, because the men are not so likely to use care in cultivating the small garden plants as they would if the garden plants were alone in a separate plat of ground. Then, too, the vegetable garden should be near the house in order to be convenient.

A rich sandy loam, or loam, soil is best adapted for most vegetables. If the plat of ground slopes slightly to the south or south-west it is all the better. A northern slope should not be chosen unless one wishes to raise late vegetables. The land should be well drained, either naturally or by under-draining. If the subsoil is very hard and compact, subsoiling will be helpful. However, under-draining and deep plowing will make subsoiling rarely necessary.

Land for vegetables should always be carefully prepared. The seed is usually small and the young plants are weak, so that it is necessary that the seed-bed be very fine and mellow. Stable manure is the most widely used fertilizer. It should be thoroughly rotted, so that the weed seeds are pretty well killed out. Men who raise large quantities of vegetables for market frequently use commercial fertilizers. The commercial fertilizers do not bring any weed seeds to the soil, while the stable manures are often quite full of them.

In the preparation of the rotted manure for the garden it is well to gather the manure from the stables and put it in a pile. As soon as it begins to heat it should be forked over so as to mix the outside with the inside. The forking over also keeps it from getting too hot and burning. Should the pile seem too dry, water can be put on, but care should be used not to add too much. It will be necessary to fork over the heap several times before it will be done heating. It can then be piled in a tall heap and allowed to stand until ready for use.

A *compost* heap is about the same as a manure heap, except that it contains all kinds of trash that will rot. Dead leaves, straw, dead vines, manure from the stables, and decaying vegetables are all dumped together in a convenient place and frequently forked over, or if the hogs have an opportunity they will usually keep the pile pretty well worked over. It is a good idea to make a foundation for the manure heap and compost heap out of blocks of sod. The pieces of sod will catch and hold the drainage water from the heap.

CHAPTER XXIII

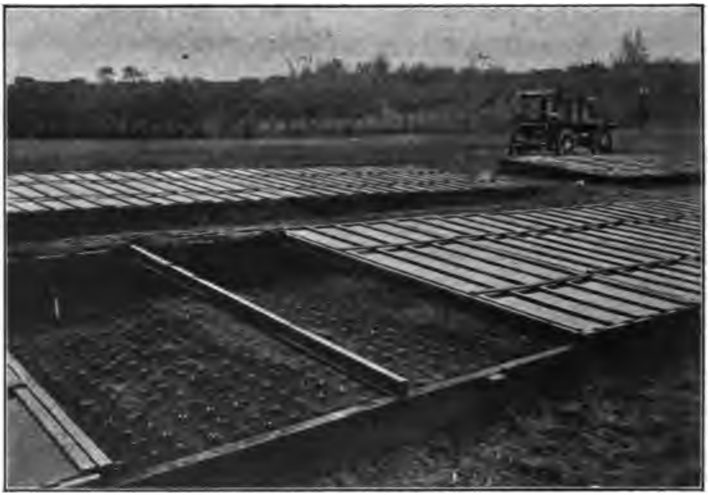
RAISING PLANTS

USUALLY the farmer buys such plants as he cannot raise early enough from seed sown in the prepared ground. Early cabbage and tomato plants are usually bought from market gardeners. Where one wishes to produce his own plants, hot-beds and cold frames are necessary.

A *hot-bed* is a box-like affair containing a good deal of manure in the bottom, over which is a layer of earth. The top is covered with window sash to let in the sun and keep out cold. The hot-bed can be of any convenient size. It is usually four to six feet wide, according to the length of the sash to be used for covering. Planks two inches thick and twelve inches or more wide are used for the back, which should be toward the north. The plank for the front should be half as wide as the back plank. This permits the sash to slope to the south and catch the sun. The planks that close the ends will have to be cut sloping from the back to the front. The planks are held in place by strong stakes and by nailing the ends. The soil on the inside can be dug out and used to bank up against the planks on the outside. This helps to keep it warm inside.

Fresh manure from the horse stables is used to fill in the bottom of the hot-bed. It is made a foot or more deep, according to the time of the year; if in early March it may be twenty inches or more deep. Before putting the manure into

the hot-bed it should be gathered into a heap and started to heating and stirred once or twice. It should be very finely broken up. The manure should be very evenly spread over the bottom and tramped solid. Over the manure are placed six or eight inches of rich soil. This soil will usually have to be prepared and stored in the autumn, as the ground is likely



30. HOT-BEDS USED FOR STARTING EARLY PLANTS
By courtesy of the Indiana Experiment Station

to be frozen or too wet in the spring. The framework should be made and the digging out of the box ought also to be done in the autumn. After the soil is put on, it should be moistened and allowed to stand until warmed by the heating of the manure. The weed seeds in the soil will soon germinate. After they have been destroyed the seed for the garden plants can be planted. A hot-bed will usually give off heat for five

or six weeks. Some attention will have to be given to the matter of ventilating the hot-bed by raising the sash a little.

A *cold-frame* is made almost exactly like a hot-bed, except that no manure for heating is used. The only heat supplied is that from the sun through the glass. A cold-frame is used usually for *hardening* plants that have been grown in a hot-bed. If cabbage and tomato plants that have been grown in a hot-bed were to be planted out in the open garden early in the spring they would probably die because of the great change from warm to cold, but if they are transplanted to the cold-frame for a few days they get hardened, so that they will stand a good deal of cold without injury. Sometimes cold-frames are used for growing lettuce and other plants that do not need much warmth.

The greenhouse is really only a collection of cold-frames and hot-beds. The heat is furnished from a furnace and a special glass building is constructed to let in the sunlight. Only gardeners who supply large markets and who grow vegetables for winter market can afford the expense of a greenhouse.

Transplanting.—The young plants of cabbages, tomatoes, and many other vegetables are usually started in the greenhouse or hot-bed, and when the weather is warm enough they are set out in the garden where they are to grow. This resetting is called *transplanting.* If possible, transplanting should be done on cloudy days or during damp weather. Where only a few plants are to be moved, they can usually be set out in the evening or before a shower. Plants do better if reset in freshly prepared ground. The soil should be pressed down closely around the roots, and the surface left loose to act as a mulch. Some gardeners pour a tinful of water around each

plant in resetting, but this is hardly necessary if the plants are set in moist soil and the earth firmed around the roots.

In transplanting it is a good idea to cut off part of the leaves so that the plant will not wilt so much. The leaves evaporate moisture, and if all are left on they evaporate more moisture than the freshly set roots can supply, and as a result the plant wilts. Clipping the ends of the leaves is the proper way to reduce the evaporating surface. If the weather is warm and sunshiny it is well to shade the plants for a few days with a shingle or some kind of covering.

Seed.—What has been said concerning good seed under Farm Crops applies equally well to all garden seeds. It is, perhaps, more difficult to get garden seeds true to name than those of the field crops. When a good variety has been found it is a good plan to save some of the very best plants and let them produce seed for the next year's vegetables.

CHAPTER XXIV

SOME OF THE COMMON VEGETABLES

MANY garden plants which are raised in gardens and truck patches are also raised on a larger scale in fields as field crops. Beets, carrots, parsnips, turnips, potatoes, onions, sweet potatoes have already been spoken of in Chapter XII. The same methods of handling those vegetables in the field apply equally as well in the garden and truck patch. The same is true of other roots, like radishes and salsify.

Beans should not be planted until the danger from frost is past. They are planted about an inch and a half deep in rows as far apart as necessary for cultivation. The plants may be five or six inches apart in the row. If they are to be used green the pods should be picked just as soon as large enough, otherwise they will begin to ripen and the plant will stop bearing. Varieties which are used green in the pods are called string beans, wax beans, or snap beans. Those which are used ripe and shelled are called shell beans. Some varieties produce long vines and need poles to climb on, but most varieties are dwarf and grow bushy without support.

Peas can be planted in spring as soon as the ground is dry enough to work. For a succession of crops they can be planted every two weeks until the first of June. Peas are used green almost entirely, the green peas being shelled out of the pods. As with beans, some varieties grow tall and need

supports, while others are dwarf. For support, brush two or three feet long can be stuck into the ground, or chicken wire fastened to posts may be used.

Cabbage-like Plants.—There are a number of vegetables closely related to and resembling cabbage which are raised in gardens for home or market purposes. Among these we have cabbage, cauliflower, broccoli, Brussels sprouts, kale, and kohl-rabi. All of these are much alike in the matter of raising. Early plants are started in hot-beds or greenhouses and then transplanted. For late plants the seed may be sown in the open, but it is always best to transplant.

The cauliflower is much like cabbage, and as soon as it begins to head the outer leaves should be tied up together over the centre to keep the sun out. Broccoli is much like cauliflower. Brussels sprouts has leaves like cabbage, but instead of one large head, at the base of each leaf there is a small head about two inches in diameter. This is the part used and it is best in the autumn, usually after being frosted. Kale is used somewhat like lettuce or "greens." It is also used late in autumn. The kohl-rabi looks like a turnip with cabbage leaves growing out all over it. It is cooked and used like turnips. The seed is usually sown where the plants are to grow and no transplanting is done.

The Potato Family.—There are a number of garden plants related to the potato, such as the tomato, pepper, and egg-plant. These plants all had their origin in a warm climate and cannot be planted in the open until the danger of frost is past, and they are killed down by the first frost in the autumn. To get an early start, young plants should be grown from seed in the hot-bed or in boxes in the house, and hardened in the cold-frame or exposed in the open to sunlight some days be-

fore planting. Tomatoes need to be supported by being tied to stakes or trellises. Tomatoes need a great deal of room and, if possible, ought to be set three feet apart each way.

Tomatoes are frequently raised as a field crop for sale to canneries. For such purpose a clover sod on loam soil furnishes one of the best conditions for success. It should be plowed rather early and frequently harrowed until time to set the plants. In the latitude of Indiana the plants are set out about June first. The plants are placed about four feet apart each way and are usually set by hand. They are cultivated frequently, the same as corn. When raised under field conditions, no supports are given to the vines. The plants will begin to produce ripe tomatoes about the middle of August and continue until frost kills them.

The Gourd Family.—The *gourd* family has a number of plants which are very useful as vegetables. Of these we may mention squash, pumpkin, muskmelon, watermelon, and cucumber. All of these have come from warm climates, —the pumpkin and squash from several sources, the muskmelon from Asia, the watermelon from Africa, and the cucumber from the East Indies.

The squash and pumpkin grow best on good loam soil. They should be planted six or eight feet apart when planted alone. Many farmers plant squash and pumpkin seeds with their corn. The vines do not grow much until after corn cultivation is over. Then they grow rapidly and sometimes produce a large number of squashes and pumpkins. However, the best yields are obtained when they are planted alone. They should not be planted until the weather is quite warm. Where extra early squashes are wanted, the plants are started in hot-beds and cold-frames and then transplanted.

There are many varieties of squash; some are known as summer squash, others as winter squash. There are two classes of pumpkins; one kind, used largely for feeding live stock, is sometimes called "cow pumpkin," but is also much used for pies. The other class is known as "sweet pump-

31. A BASKET OF CHOICE MUSKMELONS RAISED IN SOUTHERN INDIANA

Notice the finely-netted rinds

By courtesy of the Indiana Experiment Station

kin" and is used almost entirely for pies. It is not so largely grown as the first class.

Pumpkins and squashes can be kept quite late into the winter, if they are pulled before heavy frosts and set away in a cool, dry cellar or room. Pumpkins are often kept in the oats bin, or covered with corn fodder or hay in the barn.

The muskmelon grows best in a sandy soil which has been

well manured. The plants should be set four to six feet apart, with a shovelful of well rotted manure mixed with the soil of each hill. When the vines have grown several feet the ends may be pinched off. This will cause the young melons to develop better. Those varieties are best which have the rind finely netted. The melons are not ripe until they part from the stem easily.

Watermelons are raised much like muskmelons. The hills should be about eight feet apart and the vines are usually not pinched back. They need good warm soil. The grower tells a ripe melon by thumping it with his finger. One has to have much practice before he can tell a ripe watermelon without "plugging" it.

Cucumbers require a loam soil with considerable moisture. The plants should stand in hills about five or six feet apart. About three plants may be allowed to a hill. It is well to plant more seeds than one expects to mature into plants. Some plants will be puny and should be pulled out, and the insects will destroy others. This is also true of the melons, squashes, and pumpkins. Early plants can be started in hot-beds and cold-frames.

Cucumbers are used in two ways; namely, for slicing and for pickles. When used for slicing they are allowed to grow full size, but are picked while still green. For pickles they are picked at various sizes, according to the desire of the grower or customer, usually from two to three inches in length. No cucumbers should be allowed to go to seed or the vine will stop bearing. When the green cucumbers are kept picked off, the vines continue bearing until killed by the frost. Seed is obtained by letting some of the choicest cucumbers ripen on the vine.

There are a number of vegetables which are called *salad* plants. A salad plant is one the leaves of which are used green on the table, usually with a dressing of some kind over them. The leaves of some plants are wilted or cooked before serving; then they become *pot-herbs*. Pot-herbs are often called "greens."

Lettuce is our most common salad plant. It is grown very extensively in greenhouses for winter market. The seed is sown in small boxes and the young plants transplanted about twelve inches apart in beds. For early spring use, plants are started in boxes, hardened in cold-frames, and transplanted to the open. For family use most farmers sow broadcast a small bed in the open, as early in spring as possible. It is usually grown without cultivation, but if the plants are transplanted to rows twelve inches apart and cultivated, the heads are much nicer.

Other salad plants are cress, endive, chicory, and parsley. Some of the common pot-herbs are Swiss chard—a kind of beet, mustard, spinach, dandelion, and sour dock. The last two are usually not cultivated, but gathered from waste places where they grow in abundance. The package in which the seed is purchased usually gives directions for the cultivation of any of the above.

Sweet Corn when grown for table use or for canneries is to be considered a vegetable. Its cultivation does not differ from that of field corn already described, except that more stalks are allowed to grow in a hill. Planting may be made at intervals as late as July in order to furnish a succession of crops. Early Minnesota and Crosby Early are good early varieties, while Stowell's Evergreen and Country Gentleman are standard late sorts. To keep the seed of sweet corn re-

quires extra care. When the ears have ripened as much as they will on the stalk, bunches of three or four ears can be hung up in airy rooms to dry out further. They should be protected from a temperature much below freezing.

Asparagus is a native of Europe. It is very hardy and when once set it will produce a crop for many years. It will grow on any good soil not too wet. Manuring with well-rotted manure will pay well. The plants may be raised from seed sown in spring, but it is a saving of time to buy roots already started. The plants should be set about six inches deep and three or more feet apart. Transplanting should be done during the spring months. In the autumn the canes can be cut down and the land worked over three or four inches deep. It can be cultivated again in the spring. No shoots should be cut until the second spring after setting, and it is better to wait until the third. Shoots are cut when they are about four to six inches above ground and they are usually cut about two inches below the surface. Care must be taken not to cut off shoots which have not come through the ground. Cuttings may be made every few days until the middle of June. After cutting has stopped, the ground should be cultivated without regard to the rows and a good coat of rotted manure worked in. This puts the bed in shape for next spring, except that all old canes should be cut down and removed late in the autumn.

Celery is a European plant which has been introduced into this country and is raised for its leaf stems. The seed is sown in spring in small boxes. When the plants are a couple of inches high they are transplanted to larger boxes and set about two inches apart. They are set in the field about June, in rows three feet apart, and six inches apart in the row. For

family use they may be set closer. To get the stems bleached white it is necessary to keep the leaves upright and banked up with soil. Some varieties are self-bleaching without being banked up, but their flavor is improved by banking up.

Celery is stored for winter use or market by packing upright in boxes in which there are a few inches of moist sand on the bottom for the roots to stand in.

Celeriac is a kind of celery which produces an enlargement at the base of the plants like a turnip. This is the part eaten.

Rhubarb is probably a native of Asia. It may be grown from seed, but it is a saving of time to get roots already started. There should be one or more good buds to each root. These are set in the autumn in soil made rich with well-rotted manure or compost. There is no danger of getting the soil too rich. Plants should be set about three or four feet apart. The third spring the plants will come into full bearing and as many leaf-stalks can be pulled as desired. The seed stems should be kept cut down. After the ground has frozen a covering of manure should be put over the plants. In the spring this can be worked into the ground or left for a mulch.

CHAPTER XXV

III. LANDSCAPE GARDENING

By *landscape gardening* is meant the preparing, laying out, and planting of ornamental trees, shrubs, and flowers in parks, cemeteries, public squares, school grounds, lawns, and dooryards. What we shall say here will have special reference to lawns and dooryards.

The farmer and the villager very often neglect the planting of trees, shrubs, and flowers, considering it a thing not worth while, yet every one is delighted with a house surrounded by trees, vines, bushes, and flowers properly arranged. Many lawns are not pleasing because the planting has been done without any thought of its effect.

The first thing to be done in decorating grounds is to prepare the soil for the lawn and the things that are to be planted. In the first place it should be drained. Unless the subsoil is sandy or gravelly, under-drainage is very desirable for the reasons mentioned in Chapter V. The land should be deeply plowed and heavily manured. It is important to have plenty of humus in the soil. Professor Troop, of Purdue University, gives the following instructions for the making of a lawn: "Have deep, rich soil, thoroughly plowed and subsoiled, at least fifteen inches deep. Harrow down and replow across the first plowing. Harrow down again and plow once more and level off. Such preparation will give an

even surface when the land settles. Mix two bushels of blue grass seed and one bushel of red top together and sow at the rate of three to four bushels per acre. Sow by hand and rake in with a rake. Mow early and often, at least once a week. Top-dress late in fall with good well-rotted manure, or commercial fertilizers."

When the lawn has been started attention can be given to

32. AN ATTRACTIVE COUNTRY RESIDENCE

Many homes could be made attractive by the planting of flowers, shrubs, and trees

the laying out of the grounds. Walks and driveways should be first laid out. For small yards there should be no driveway, unless absolutely necessary. Better to be slightly inconvenienced than to have a driveway used only seldom. There should be as few walks as possible and they should not have needless curves in them. If fences are necessary they should be inconspicuous.

When planning for the planting of the trees and shrubbery,

bear in mind that the house is the centre of the landscape and that the view to or from it should be obstructed as little as possible. It is desirable to have the lawn directly in front of the house perfectly open, except for a flower bed or two of low-growing plants. Trees, shrubs, and tall-growing flowers are to be planted to the side and back of the lawn. Undesirable views are to be hidden by clumps of shrubbery. The driveway and fence should be hidden by vines and tall-growing flowers. Attractive views in the neighborhood are to be made as available as possible.

In planting it is desirable to mass plants together rather than to have them standing singly. Many kinds together give variety and a pleasing appearance. The appearance is improved if they are set rather hap-hazard. They then appear to have grown up naturally. Professor Bailey of Cornell University, says: "When planting, do not aim at designs or effects; just have lots of flowers, a variety of them, growing luxuriantly, as if they could not help it." * For small grounds very few trees should be used and these should be so placed as to be of most service as shade and not hinder views. Evergreens should be set so as to screen undesired views. Their lower limbs should never be pruned, nor should they be sheared into fanciful forms, if a natural landscape is desired. Shrubs and vines are used as backgrounds for low-growing flowers. A large shrub or rose bush at the corner of the house has a good effect. The lawn should not be cut up by numerous flower beds. Unless it is quite large one or two beds carefully placed is all that will look well in a lawn. It is better to plant flowers along the edge of the shrubbery, around the house, and bordering the driveway and fences.

* *Garden Making.*

Artificial mounds in the lawn are seldom artistic. If borders are planted so as to bulge out at one place and to dip in at another with irregular or ragged edges they will have the effect of making the grounds seem larger.

CHAPTER XXVI

PLANTS THAT MAY BE USED

There are many plants that are useful for decorative purposes. One should choose such as are easily obtained and inexpensive. Oddities are usually out of place in small grounds. The forest, thicket, river and creek bank, old fence rows, and other neglected places will furnish the best trees, shrubs, and wild flowers. One can well take a lesson from Nature's method of planting and beautifying landscapes. Wild plants should usually be moved in the autumn. Seeds of wild flowers can be sown in the autumn or during the winter.

Of the trees, the common forest trees are quite appropriate and, as a rule, are easily transplanted. For small grounds those which grow slowly and do not grow too tall are best. Elm, sugar, and soft maples, oaks, bass-wood, ash, coffee nut, birch, buckeye, and many others may be used. The Norway maple, cut-leaved weeping maple, cut-leaved weeping birch, and Kilmarnock weeping willow may be obtained from nurseries. Arbor vitæ, the spruces and pines, cedar, fir, and juniper are evergreens that grow easily and are quite effective as screens. Evergreens in large numbers should not be used.

Of the shrubs that may be used the following are some of the best: the wild thorn or red haw, red bud, wild crab-apple, iron-wood, wild rose, and wild laurel. From the nurseries the following may be obtained: lilac, snowball, spirea, rose, barberry, and fragrant currant. Clematis, grape, trumpet-

creeper, Virginia creeper, honeysuckle, wistaria, hop, scarlet runner, and others are good vines for covering fences, porches, and outbuildings. Wild flowers like the golden-rod, aster, sunflower, and flag look well when planted along the edges and among shrubs from the forest.

There are many cultivated flowers that can be used for flower beds and borders. Some of these require special preparation of the soil, but for most of them it is necessary only that the soil be rich and deeply prepared and that the roots or seeds be properly planted. We may divide these plants into those which grow from bulbs or tubers and those which come from seeds. The bulbs and tubers are of two kinds: those planted in autumn and those planted in spring.

The common fall-planted bulbs are tulip, crocus, jonquil, daffodil, hyacinth, lily, and lily-of-the-valley. There are many varieties of most of these and one can choose what pleases the fancy and will suit the conditions. There are said to be over two hundred varieties of hyacinths alone. Crocuses are frequently planted in the grass in the lawn, making a beautiful sight when they bloom early in the spring. Crocuses, daffodils, and jonquils should be planted in September or early October; the others may be planted in October and early November. Crocuses and tulips should be covered about three inches deep, jonquils and hyacinths about four or five inches, and daffodils and lilies about six inches. It is well to cover most of them with a light covering of manure or straw after the ground freezes and remove it early in spring.

The lilies and lilies-of-the-valley may remain where they are set for several years, but hyacinths and tulips are better taken up each year and reset. The crocuses may stand two years or longer. The daffodils and jonquils are best reset about

every four years. All of these flowers increase by producing new bulbs around the old ones, and if they were not reset they would soon become so crowded as not to flower well. The lifting of the roots is done after the plants are through flowering and the leaves have begun to turn yellow.

The dahlia and gladiolus are the common spring-planted roots. The dahlia may be started in boxes before time to set out in the open. Usually the cluster of tubers is divided and a single tuber with a bud is set by itself. Barely moist earth and a rather low temperature are best for starting sturdy plants. After danger of frost is past the plants may be set out in the beds where they are to grow. They will grow rapidly and bloom early. Roots which have not been started may be set out for late blooming as soon as danger of frost is past. The roots may stay in the ground in the autumn till after frost has killed the tops. They should be dug before the ground freezes, the moisture dried off, and stored in a cool, dry place.

Gladiolus grows best in sandy loam soil, but can be produced satisfactorily under almost any conditions. The bulb of gladiolus is not a true bulb, but is what is called a *corm.* It differs from a bulb in not being made up of layers. These corms are planted about two or three inches deep. The planting may begin early in spring and be continued at intervals until the last of June. This will give a succession of blossoms. The gladiolus increases by means of small corms formed at the base of the old one. These little corms should be saved and planted the next spring. In two years they will produce flowers. The gladiolus corms are lifted in the autumn, after frosts have killed the tops, and are stored away in a cool, dry cellar.

Besides these cultivated tubers and bulbs there are many wild flowers that grow from under-ground parts which can be easily transplanted to the borders and flower beds. Most of them like shade and a soil rich in rotten leaves. One should study their native homes and try to give them somewhat the same conditions in the lawn. Some of the more common of these plants are spring beauty, trilliums, bloodroot, dog-tooth violet or adder's-tongue, lilies, and wild flags. The last should be planted in wet places by the well or cistern.

The list of flowers that may be produced from seeds sown in the spring or autumn is very long. A few of the common ones are aster, zinnia, marigold, holly-hock, larkspur, touch-me-not, pansy, sweet pea, sweet-william, verbena, four o'clock, phlox, salvia, nasturtium, and pink. Directions for growing these plants are usually given on the package in which the seed is purchased. The only direction necessary is to have rich soil well prepared and a little attention given not to crowd slow-growing, tender sorts with rapid-growing, sturdy ones.

There are also a number of hardy plants which, when once set, bloom from year to year without much attention, more than working in some rotted manure in the autumn and covering them with a light covering of coarse litter for winter protection. Such plants are peony, bleeding-heart, chrysanthemum, and columbine.

CHAPTER XXVII

INSECTS—INJURIOUS AND BENEFICIAL

MUCH damage is done our field, garden, and orchard crops every year by insects. It is estimated that more than three hundred million dollars' worth of crops is destroyed every year by them. However, we must not condemn all insects, for all are not injurious. Some are quite useful and we do ourselves injury when we kill them.

The life of an insect is very interesting and may be divided into four stages. The first is the *egg* state. Every insect is developed from an egg; though under certain conditions plant-lice and some scale insects are born alive. The second stage is the *larval* or worm stage. After the egg hatches, the insect exists for some time as a worm, eating the foliage or roots or sucking the juices of the plant. During the time that it is a worm, the insect grows larger and larger, and to accommodate its increased size it changes its skin one or more times. The third stage is the *resting* stage. This is also called the pupa or chrysalis stage. Some insects do not stay in this stage very long, others do for several months. Every one has seen the silken cocoons that some insects weave around themselves when they go into the resting stage. Many insects do not make a cocoon, but their skin hardens and they rest quietly in that form for a time. When the insect comes out of its cocoon, or hard case, it is quite different in

appearance from the worm which it was before. It may be a beetle, a fly, a honey-bee, or a beautiful butterfly. This stage is called the *adult* or *imago* stage. Some insects, like the grasshoppers and the squash-bugs, do not go through these four changes very completely, but in every insect the four stages are more or less clearly marked. Insects usually do the most harm in the second, or larval, stage of their lives.

There are thousands of kinds of insects. The farmer and fruit-grower is interested in many of them, for some injure his crops, while others are useful to him. We can mention here only a few which must serve as examples for all.

1. **Plant-Lice.**—These are to be found on all kinds of plants, more often on trees and bushes. They are usually quite small, greenish-colored, and soft-bodied. They suck the juices of plants. The leaves wrinkle or curl up and hide the lice inside. Plant-lice have a little projection on the back part of their body from which honeydew is exuded. If there are ants around one can see the ant go up to the louse and stroke it on the back with its antennæ. The plant-louse gives up a drop of honeydew and the ant eats it. For such accommodation the ants care for some kinds of plant-lice by taking them into the ground and protecting them over winter. Plant-lice on the roots of corn are placed there by the ants. So if there are many ants running around the plants of corn we may be sure that there will be some lice on the corn roots. Plant-lice usually pass the winter in the egg stage and hatch early in spring, and there are several broods during the summer.

2. **Scale Insects.**—There are many kinds of these, the worst of which is the San José scale. Scale insects are flat and scale-like in appearance and are usually covered with a hard, crust-like covering. They are nearly always found on

trees and bushes. In color they are sometimes white, but more often dark-colored like the bark on which they rest. Like the plant-lice, they suck the juices of plants, but ants do not care for them. Some kinds pass the winter as adult insects and other kinds live through in the egg stage.

33. SAN JOSÉ SCALE ON BARK (MUCH ENLARGED)
Notice the peculiar shell-like covering of the insect. One must use a magnifying glass to identify the scale
By courtesy of the Ohio Agricultural Experiment Station

3. **Cutworms.**—These insects do the farmers and gardeners much damage every year. The damage is usually greatest on sod land plowed in the spring. The cutworm is a dark-colored worm, usually some shade of gray, with faint stripes running lengthwise of the body. The body is soft and easily crushed. The adult form of the cutworm is a moth. A *moth* looks like a butterfly, but it is not so brilliantly colored and flies at night instead of by day as the butterflies do. Moths are attracted into our rooms at night in the summer-time by the lights. The cutworm moth lays its eggs on the stems and blades of grass or clover in the summer. When the eggs hatch the larvæ go to the roots of the plant and become partly grown before cold weather. They remain in the ground

all winter and in spring begin to eat everything within reach. In orchards some kinds of cutworms crawl up the trunks of trees and cut off the young shoots. The cutworm cuts off the corn or garden plants just above the surface of the ground. If sod is plowed early in the fall the moths have to find other places to lay their eggs, so that not many will be found in the field next spring. Late plowing disturbs the winter bed of the larvæ and causes many to be killed by the cold.

4. **Hessian Fly.**—This is a very small fly, like what is usually called a gnat. The eggs are laid on the upper surfaces of the lower leaves of wheat or other grass-like plants. As soon as hatched the larva slips down inside of the sheath and begins to absorb the juice of the plant. The larva is a maggot and cannot chew the plant but absorbs its juices. At first it is white but when it is full grown it is brown. Eggs are laid in the fall and in the spring, so that there are two broods each year. Adult flies come from the larvæ in the spring. These at once lay eggs for the summer brood which comes forth late in the summer, ready to lay eggs on the fall-sown wheat.

5. **Codling-Moth.**—This moth lays the egg that makes the worm which we find in apples in the summer-time. The egg is laid at the blossom end of the apple just as the blossoms drop off in spring. The egg soon hatches, the worm eats outside a couple of days, then works into the apple and eats around the core until it is full grown. It then comes out and finds a hiding-place under the bark, spins a cocoon, and rests until next spring when it hatches out as a moth again. In most places there are two broods. The first larvæ change to moths early in summer, and these moths lay eggs on the green apples, generally where two apples touch each other.

6. **Plum Curculio.**—The plum curculio is a beetle, that is, an insect with a set of shell-like wings covering its true wings. The curculio head and mouth parts are prolonged into a proboscis. The curculio lays its eggs on plums, cherries, peaches, apricots, pears, and apples. The beetle itself feeds

34. A CURCULIO CATCHER
The insects are jarred on to the sheet and then swept into a bucket and killed
By courtesy of the New York (Cornell) Experiment Station

on the foliage of these trees, and when the fruit is about the size of a marble it makes a crescent-shaped slit in the skin, raises the flap, and puts an egg under it. This soon hatches and the larva bores down to the seed of the fruit. This causes the plums, peaches, apricots, and cherries to fall off and rot. The larva develops in the rotten fruit, comes out and hides away until next spring. Those in the apples and pears cannot develop unless the fruit falls off from some other cause. If there are hogs and sheep in the orchard to eat up the

The adult insects

Masses of gum at base of tree infested with borers

Larvæ on a trunk that has been injured

35 THE PEACH TREE BORER AND ITS WORK

By courtesy of the New York (Cornell) Experiment Station

fallen fruit most of the insects are killed. There are many kinds of curculio which attack other plants, but none are so injurious as the plum curculio. Jarring the curculios from the tree upon sheets very early in the morning is a good way to keep them in check. Poultry in the plum orchard will catch many of them.

7. **Borers.**—There are many species of insects which bore into the trunks of trees, the stems of bushes, and the roots of non-woody plants. Some of the worst of these are the peach-borer, fruit-bark beetle, bill-bug, blackberry borer, currant borer, and strawberry root-borer. In most cases the eggs are laid on the stem, and after hatching the larvæ bore into the stem or under the bark, causing the plant to wilt and die.

8. **Beetles.**—Many species of beetles are beneficial; among them are most of the black beetles which run about on the ground. These beetles and their larvæ feed on cutworms and other larvæ which injure the roots of plants. The lady-bird beetles destroy large numbers of plant-lice. They are small, hemispherical beetles, usually some shade of brown in color, with spots on their wing covers. The larvæ of the lady-bird beetles are small, ugly, black, spiny worms, but they destroy plant-lice.

Among the injurious beetles are the *potato-beetles*. There are two kinds of these which do the most damage. One is the "Colorado potato-bug," and the other is a blister-beetle usually called the "old-fashioned potato-bug." The eggs of the "Colorado potato-bug" are laid on the under side of the leaf early in spring. The eggs soon hatch, the young grow vigorously and are soon full grown. This first brood now lays eggs for a second brood which becomes full grown and passes the

winter hidden away in the ground or under trash ready for the next year's potato crop. The eggs of the "old-fashioned potato-bug" are laid in the ground, and while young the larvæ feed on the eggs of the grasshopper, which are laid in the ground also. These larvæ do not become adults until the second year, when, as adults, they do much damage to potato vines.

Many of the borers are beetles, especially those that work in forest trees. One of the most troublesome of the borers is the fruit-bark beetle which makes little channels in the sap wood just under the bark of fruit trees. The rose-chafer does great damage in some places to vineyards, orchards, and gardens by eating the blossoms. The eggs are laid in the grass and the larvæ feed on the roots of grass and other plants. In spring the adults appear and attack the blossoms of any kind of fruit.

One other beetle which we must mention is the "May-beetle" or "June-bug" or "cock-chafer." It is the large beetle which flies in at windows and doors at night in the spring. There are several species of these, but all look alike unless one is making a careful study. The eggs are laid in grass-land and the larvæ feed on the grass roots. They are what we call "grub-worms," and when the sod is put to corn they often do much damage by eating the roots. Some species live in the ground for two or more years before changing to the adult stage. The adults often do damage by eating the foliage of trees and bushes.

9. **Caterpillars.**—There are several familiar examples of these insects. One is the tent-caterpillar, which spins the large white web so often seen in orchards and works inside it; another is the fall web-worm, which also spins a web and

works inside it, but which does not become noticeable until the summer months; still another is the yellow-necked caterpillar, which feeds on the apple foliage. There are other species, much like the yellow-neck, which feed in great numbers on walnut, hickory, and other trees. Finally, there is the green cabbage-worm. The adult from all caterpillars is either a moth or a butterfly.

The eggs of the tent-caterpillar and of the fall web-worm are laid in masses on the trees. The larvæ feed greedily on the leaves and when full grown they drop to the ground and change to the chrysalis form. The tent-caterpillar changes to the adult stage before cold weather and lays its eggs for next year in a compact mass completely encircling a twig. The second brood of the fall web-worm does not change to the adult form until spring.

The yellow-necked caterpillar and its close relatives hatch from eggs laid on the leaves. The young feed together until they are nearly grown, when they begin to scatter over the tree. They change to the pupa stage in the ground and remain there until spring. One can see the moulting habit in this insect better than in almost any other. When they are ready to change their skins they travel down to the trunk of the tree and gather in a large mass. In about a day they slip out of the old skin and travel back to their feeding-place. However, they take a new place each time. They shed their skins three or four times, each time leaving the mass of empty skins hanging on the body of the tree.

The beautiful white butterfly which lays the eggs for the cabbage-worm is known by every one. The eggs are laid singly on the under side of the cabbage leaf. When the larvæ are ready to pupate they enclose themselves in a papery cocoon,

fastened under the weather-boarding of a house or any other projecting ledge.

10. **Chinch-Bug.**—This is one of the most destructive insects that attacks farm crops. It is a true bug. All *true bugs* have their mouth parts prolonged into a sharp beak with which they puncture the skin or bark of the plant and suck the juices instead of chewing the foliage or stem. The chinch-bug hibernates over winter, hiding anywhere that it can find protection in trash or stubble. Early in spring it lays its eggs on the stems or roots of grass or wheat near the surface. By the middle of summer the young are full grown. They then begin to travel from one field to another. As soon as wheat is ripe they go into the oats or corn. They are difficult to control. All trash should be cleaned up so they will not have good places to hibernate. When they begin to travel a trench made around the field into which they are moving and made dusty by dragging a log in it will hinder them, as they cannot climb up the dusty sides. Straw scattered in the trench and burned will kill those thus trapped.

11. **Parasitic Insects.**—By parasitic insects are meant those insects which lay their eggs in the bodies of other insects. When the eggs hatch the larvæ live in the body of the attacked insect and feed upon it. By the time the larvæ are full grown the insect is dead. In almost every case the parasitic insects are beneficial.

One of these parasitic insects attacks the tomato and tobacco-worm. When it is full grown it spins a small white cocoon on the back of the worm. Every one has seen the large tomato-worm with a dozen or more of these white cocoons on its back. The Hessian fly is also attacked by another small fly which destroys it. There are many kinds of

parasitic insects which attack many other kinds of insects. They are one of Nature's means for holding insect pests in check.

There are a few parasites which are decidedly troublesome to the farmer. These are the lice and ticks which live on all kinds of live-stock and occasionally even on man.

CHAPTER XXVIII

CONTROLLING INSECTS

It is almost impossible to exterminate completely any kind of insect, so that our fight against them must be with the intention of holding them in check. There are four principal methods of doing this. Two of them are Nature's ways and two are means devised by man.

1. **Parasitic Enemies.**—As was just mentioned in the last chapter, there are many insects which get all their subsistence from other insects. It is often noticed that the Hessian fly is quite troublesome for two or three years and then is not seen again for several years. This is due to the attack of its parasite which increases in such numbers that nearly all the Hessian flies are killed. Then the parasite, having nothing to live on, dies off and the Hessian fly has a chance to increase again. In a similar way many other insects are held in check. Besides the parasitic insects there are those like the lady-bird beetle and many others which attack and destroy destructive insects.

2. **Birds, Snakes, and Toads.**—Some of Nature's most effective agents in destroying insects are not fully appreciated by man. Almost every kind of bird destroys some insects, and a majority of our land birds live almost entirely on insects, especially during the growing season. Certainly every one has seen the robins, chipping sparrows, bluebirds, black-

birds, song-sparrows, and wrens gathering insects for their young. The woodpeckers, nuthatches, and brown creepers search up and down the trees for the eggs and young of insects destructive to trees and peck holes through the bark to dig out borers. The vireos, orioles, and warblers search the foliage for worms and destroy countless numbers. The cuckoo, or raincrow, destroys the tents of the tent-caterpillar; the catbird, brown thrasher, and thrushes get insects from the ground and from the trees. No more useful insect-destroyers are to be found than the quail and the meadow lark, yet farmers often allow these birds to be killed by sportsmen. It would take an entire book alone to tell all the useful habits of our common birds. Each needs to be studied carefully and protected.

36. A PARASITIC INSECT
This one destroys tree borers
By courtesy of the Indiana Experiment Station

Snakes are unpleasant animals, but nearly all of them are destroyers of large numbers of insects. The garter-snakes and blue racers are most common and most effective. However, they destroy many toads, and the toad is probably more effective than the snake and much more pleasant.

Toads live entirely on insects and catch great numbers of them. It has been estimated that a single toad is worth nearly twenty dollars a season in a field or garden. It is said that English gardeners often pay twenty-five dollars a hundred for toads to put into their gardens.* They will eat practically any kind of insect. They are said to be a sure remedy for cockroaches.

* Farmers' Bulletin, No. 196.

Toads lay their eggs in the water just as frogs do. Every one should become interested in toads and protect them. There is no truth in the statement that handling toads will produce warts on the hands.

3. **Cultivation.**—Cultivation is one of the methods that man has learned to use for combating insects. The rotation of crops, as mentioned in Chapter XVI, is very effective in holding in check certain.kinds of insects. When the particular plant upon which an insect feeds is not planted in the same field each year, it finds it difficult to travel after its food and often perishes. Farmers who practice rotation of crops rarely have much trouble with the corn-root louse, Hessian fly, chinch-bug, and many other insects. One of the best means of preventing damage from the Hessian fly is to sow a narrow strip of wheat around the field several weeks before the main crop is to be sowed. The fly will gather in this strip and lay all its eggs on the early wheat. Just before sowing the main crop the narrow strip should be plowed under and the land harrowed down. The larvæ in the young wheat are not old enough to live over the winter without more fresh food, and so all perish.

4. **Spraying.**—In spraying plants to keep off insects it should always be kept in mind that some insects destroy the plant by chewing the foliage or stem, while others pierce the skin or bark with their sharp mouth parts and suck out the juices, causing the plant to wilt and die. For those insects which chew their food a poison is applied to their food, but for those which suck the juices of the plants such application does no good, and the remedy applied must be one that will kill the insect by contact. In the first class we have all the beetles, caterpillars, and grasshoppers; in the second, the

plant-lice, scale insects, and true bugs, like the chinch-bug and squash-bug.

There are two ways of applying poisons: one in the form of a fine spray of water, and the other as a dust of dry powder. For trees and bushes and for large areas the spray is always used. We cannot mention all the various sprays used, but the following are a few of the common ones:

37*a*. RESULTS OF SPRAYING

The crop of one tree. The large pile is good fruit; the small pile poor.

By courtesy of the Ohio Experiment Station

1. *Paris Green* is one of the most widely used poisons. It is used at the rate of one pound to 150 to 200 gallons of water, or for small quantities about a half-teaspoonful to a gallon of water. It should be thoroughly stirred before using. It is well to add a little lime, as lime keeps the Paris green from burning the leaves when the sun is hot. Paris green will kill all insects that chew the foliage.

2. *London Purple* is used exactly as Paris green. It generally sticks to the foliage longer than Paris green.

3. *White Hellebore* is usually dusted on to kill insects. When used as a spray an ounce to three gallons of water is about right. White hellebore is used mainly for currant-worms on currant and gooseberry bushes.

4. *Pyrethrum* is dusted on when the leaves are damp or may be used as a spray at the rate of an ounce to two gallons of water. When not in use the powder should be kept in an air-tight can. This powder will kill currant-worms, cabbage-worms, and many others.

37*b*. RESULTS OF NOT SPRAYING
The crop of one tree. The piles of good and poor fruit are about equal in this case.
By courtesy of the Ohio Experiment Station

5. *Whale-oil Soap* is a good remedy for San José and other scales. It is used at the rate of two pounds of soap to one gallon of water. The soap should be thoroughly dissolved and applied as a fine spray. It kills by contact.

6. *Kerosene Emulsion* is widely used for soft-bodied insects like plant-lice and many kinds of scales, as well as hard-bodied insects. It is made by dissolving a half-pound of hard soap in one gallon of water (soft water is best). While still hot, two gallons of kerosene should be added and thoroughly churned with a force-pump, or stirred with a stick, until the mass is like cream. It will take several minutes to do the mixing right. If small quantities are wanted the above

amounts may be divided. When wanted for use, the emulsion is diluted by taking one part of emulsion to ten parts of water for hard-bodied insects, or one part to fifteen of water for soft-bodied ones. It should be applied with a very fine spray. Kerosene emulsion kills by contact.

Poisons are applied by various kinds of apparatus. For large operations, as in orchards, spray-pumps operated by

38. A POWER SPRAYER USED IN THE ORCHARD AT PURDUE UNIVERSITY
By courtesy of the Indiana Experiment Station

compressed air are used. Spray-pumps operated by hand are much used. For spraying potatoes and sugar beets a barrel is mounted on a truck and the contents are forced out of nozzles attached to a frame behind the truck. For gardens and flower beds a garden spray-pump can be used, and even a sprinkling-can is useful for small operations. For applying dry powders various kinds of bellows are used.

The time of spraying is important. It is often done too late. Usually spraying should not be done when plants are

in blossom, for in so doing many useful insects which aid in pollenizing the blossoms will be killed. As soon as the blossoms drop, all tree fruits should be sprayed. This will catch the codling-moth on apples. Potatoes should be sprayed as soon as they are a few inches high. Since rains usually wash off the sprays, spraying should be done several times during a season. Then, too, some substances lose their effectiveness after being exposed for a time.

All experiment stations publish bulletins about insects and spraying. These can always be had free for the asking.

CHAPTER XXIX

PLANT DISEASES AND THEIR TREATMENT

THERE are many diseases which attack the farmer's crops and fruits. They are often quite injurious and cut down the yield very much, and sometimes completely destroy the crops. For some of these diseases no remedy has been discovered as yet, while for many of them we know what to do, and when properly handled they cause little injury. We shall speak of only a few of the common plant diseases.

1. **Smuts.**—The oat smut is one of the most common. It shows itself when the oats begin to head out. The heads turn black and become a mass of black or brownish dust. This dust is the seed of the smut and is called the *spores*. When the ripe oats are cut these blasted heads are also gathered into the bundles, and when threshed some of these spores get mixed with the oats. Next spring when oats are sowed some of these spores go into the ground and, sprouting, grow into the tissues of the plant until heading time when they show in the blackened head. Oat smut can be controlled by spraying the seed oats until they are damp with formalin at the rate of one pound of formalin to fifty gallons of water.* The formalin should be full forty per cent. solution of formaldehyde. The oats should be piled in a heap and covered for a half-hour or more and then spread out to dry.

* Farmers' Bulletin, 250.

There is a similar loose smut which attacks wheat and barley, but no effective remedy is known for it. Wheat is often attacked by a smut which makes the inside of the grain a mass of black powder or spores. The kernel when broken open has a bad odor. This is known as stinking smut. It can be controlled by treating the seed wheat with formalin the same as for oat smut. We often see large black masses attached to corn plants. This is corn smut. No sure remedy is known for it. It is best to collect all such masses and burn them on the trash pile.

2. **Rusts.**—There are many kinds of rusts and they are to be found on nearly all species of plants. One of the most common is the wheat rust. Wheat rust is of two kinds. The kind that makes the reddish spots on the leaves is called *orange-leaf rust*. The kind that forms blackish blotches on the stem is known as *black-stem rust*. No remedy is known. The same rusts attack oats and barley, but rarely rye.

Growers of blackberries, raspberries, and dewberries often have their plants attacked by a rust known as anthracnose. It appears as gray patches with distinct purple borders on the lower part of the stems and soon causes them to wilt and die. The best remedy is to cut out and burn all diseased stems. Spraying with copper sulphate solution before the buds open and with Bordeaux mixture afterward is helpful.

3. **Blights.**—A disease which causes the leaves of a plant to wither and die without any very easily discovered cause is usually called a *blight*. Pears and quinces are often attacked by leaf-blight, which causes the leaves to die and fall to the ground. The twigs appear black and dead and the fruit becomes hard and knotty. This blight can be controlled by spraying with Bordeaux mixture several times during the

spring months, beginning as soon as the first leaves are opened.

There is another leaf-blight which attacks pears, quinces, and apples and makes the leaves look as if they had been scorched by fire. The leaves do not fall off as in the case of the other leaf-blight. This blight is called fire-blight or twig-blight. There is no remedy but to cut out the affected twigs and burn them.

Another serious disease which may be called a blight is the black knot of plum and cherry trees. The twigs and limbs swell at various points, becoming larger than the surrounding parts. The swellings become very black by winter. The next spring the swellings continue to increase at their edges until the twig or limb dies. There is no effective remedy. Cutting off the attacked limbs some distance from the swelling is probably best. Painting the knots with kerosene is also helpful. Spraying with Bordeaux mixture will tend to prevent the starting of new swellings.

Potatoes are attacked by two bad blights. One is the early blight and the other is the late blight. The early blight appears as circular yellow spots near the edges of the leaves. As time goes on, the spots increase in size, become brown in color, the leaves roll up, the stems become affected, and the plant dies. Dry weather seems to be favorable to this disease. This blight is not fully understood yet, but spraying with Bordeaux mixture has been beneficial. The late blight is helped by warm, moist weather and soon destroys a potato plant. This blight appears as irregular-shaped brown spots anywhere on the leaves and spreads rapidly, soon killing the plants. In the case of this blight the potatoes in the ground also rot. This blight usually appears later in the season than

the early blight. Thorough spraying with Bordeaux mixture will control this disease. Spraying should begin when the tops are about six inches tall.

The leaves of peach-trees sometimes curl up, turn yellow, and fall off. Another set of leaves soon comes out again. This disease is called leaf curl. It is treated by spraying with

39. A POTATO SPRAYER FOR BUGS AND BLIGHTS
This kind is useful in large fields

copper sulphate solution before the buds open and afterward with Bordeaux mixture.

Peach Yellows is a disease in which the peaches ripen too soon and have red streaks in them. The next year the leaves come out in tufts and are yellowish in color. The cause is not known, nor has any remedy been successful. The disease will spread easily and all attacked trees should be cut down and burned.

4. **Wilt.**—Where flax has been grown for a number of years on the same piece of ground without rotation, it usually

becomes diseased. The plants begin to look sickly, wilt, and die. This is called flax wilt. It can be controlled by practicing a rotation and by spraying the seed until moist with formalin at the rate of one pound of formalin to forty-five gallons of water.

Cow-peas grown continuously on the same piece of ground are also often attacked by a wilt. It is controlled by rotation and planting varieties which are not easily effected by the disease.

5. **Rot.**—Many plants are attacked by diseases which are called "rot." There are several forms of rot and each would have to be described separately. Some of the worst forms are the *bitter rot* of apples, two or three kinds of rot which attack grapes, and the tomato rot. In a general way these can be controlled by the use of Bordeaux mixture, and by picking and destroying all fruit beginning to decay.

6. **Scab.**—Scab is a disease indicated by rough and knotty places on the skins of the fruit. In the case of potato scab, it gives the potato the appearance of having been chewed by an insect. For the scab on apples and pears it is well to spray with Bordeaux mixture several times during the season, beginning early in spring before the buds open. Potato scab is controlled, first, by planting in a new field each year, and, secondly, by soaking the tubers in a solution of formalin made by using one pound of formalin to thirty gallons of water. The potatoes should be soaked two hours in this solution before planting.

Bordeaux Mixture.—This mixture is made as follows: Dissolve four pounds of copper sulphate in hot water. Then slake four pounds of lime in a separate vessel and add water until it is like milk. Strain the lime through a sieve to re-

move chunks. Mix the lime and copper sulphate by pouring from each vessel at the same time into a third vessel. It is very important to do this in order to get a perfect mixture. Stir up this mixture with fifty gallons of water in a coal-oil barrel. When it is desired to spray for insects and plant diseases at the same time, four ounces of Paris green or London purple can be added to the above quantities. For tender plants only one-half of the quantities of lime and copper sulphate should be used.

Copper Sulphate Solution.—This is made exactly as the Bordeaux mixture, except that the lime is left out. It is to be used only before the buds begin to swell.

SECTION IV.—ANIMAL HUSBANDRY

CHAPTER XXX

FARM ANIMALS: I. THE HORSE

BY farm animals we mean horses, mules, cattle, sheep, goats, swine, and poultry. These animals have been known and used by man for many centuries. At first they existed as wild animals. As man found use for them he gradually tamed and developed them. There are many different kinds of each, brought to their present state of development by the nature of the climate in which they live, the use to which they have been put by man, selection and improvement by breeders, and various other causes.

The Horse.—The discoveries of geologists tell us that horses have developed from queer animals which lived ages ago. These animals had five toes on each foot and in size were about as large as a fox-terrier, but as ages went by they were modified by the climatic and food conditions until there was developed an animal much like our present horse. The splint bones which are often seen on the legs of horses are the remains of what were once toes. The color of the prehistoric horse is thought to have been striped, somewhat like the zebra.

The horse was originally a native of Central Asia. When man began to use and breed horses he modified them very

much to suit his needs and fancy, and in this way it happens that we have so many different breeds. We shall consider a few of the more common ones.

There are two general types of horses; viz., the draft type and the harness type. The draft type is a low, heavily built

40. MARINDAS, (62414) 42696
A prize winning Percheron imported from France

horse with strong legs and large feet. His movements are comparatively slow and he is adapted to drawing heavy loads. The harness type has a smaller body, smaller and longer limbs, and smaller feet. He is fitted for rapid movements and drawing light loads. The draft type was developed in northern Europe from what has been called the Black Horse

of Flanders. The speed type has been developed largely from the Arabian horse.

Draft Types.—1. *The Percheron.*—This breed gets its name from the province of La Perche, in France, where it was

41. ROYAL PRINCE, FIRST PRIZE THREE-YEAR-OLD CLYDESDALE STALLION
International Live Stock Show, Chicago, December, 1908

first developed. The Black Horse of northern Europe seems to have been mated to stallions from Arabia. The breed is large, active, and strong. The legs have very little long hair on them. The Percheron is superior in legs and sound feet.

Stallions usually weigh 1,750 to 2,200 pounds, and mares 1,500 to 1,800 pounds. The most common colors are grays

and blacks, but bays and browns are sometimes seen. The Percheron breed is very popular in the United States, and no other draft breed is so largely bred pure.

There are other breeds of draft-horses brought to America in small numbers from France, which are frequently called French Draft. This term includes a number of draft types. The names Percheron-Norman and Norman are local names and are not generally used. They usually refer to the Percheron breed.

2. *Clydesdale.*—This breed originated in Scotland from the breeding of the native mares to Black stallions brought from Flanders. The Clydesdale horse is noted for his rapid walk and long stride. This breed is usually bay or brown with a white marking on the forehead or face. The legs are usually white up to the knees and hocks, and there is a considerable amount of long hair on the legs. This long hair is called "the feather" by horsemen. The nose should be straight, not dished nor bulged as is often seen. The back of the Clydesdale is somewhat longer than that of other breeds. Stallions usually weigh about 2,000 pounds and mares about 1,800 pounds. Next to the Percheron the Clydesdale is probably the most popular draft-horse raised in America.

3. *The Shire.*—The Shire horse is the great draft breed of England. In America it is best known in Canada and the north central states. It is also popular in large cities for heavy draying. This breed doubtless also originated in the Black Horse of Flanders, but was developed and improved in England. The Shire is exceeded in size by the Belgian only. He differs from the Clydesdale in having a shorter back, more "feather" on the legs, flatter foot, and a slower movement. The foot is so flat as to be sometimes quite ob-

jectionable. Shire horses are good-natured and are very popular with those who handle them. They are usually black, bay, and brown, with white on the face and on the legs below the knee and hock.

4. *The Belgian.*—In ancient times Belgium was the greatest horse-breeding country in the world. In recent times it has again begun to attract attention. The Belgian breed is not well known in the United States, being confined mainly to Iowa, Illinois, and Indiana. The Belgian is a very compact, blocky horse, with broad breast and back, short legs, rather small feet, and somewhat slow in action. The legs have very little hair on them. In color the breed is sorrel, bay, and roan. Those coming from that part of Belgium known as Flanders are the largest and heaviest of draft-horses.

5. *The Suffolk.*—This is often known as Suffolk Punch, a name given it because of the round, full body which is characteristic of the breed. The Suffolk breed has been bred pure in Suffolk County, England, at least as far back as 1768. The breed is not so large and heavy as the Clydesdale and Shire, but combines great strength with rapid action and is a favorite farm horse in England. The established color is chestnut, never anything else. There are as yet few Suffolk horses in the United States.

The Harness Type.—This type may be divided into two classes: the heavy-harness class and the light-harness class. The heavy-harness class combines weight, strength, and rapid action. Horses of this class are fitted for carriage and coach purposes, as well as being useful for general farm work and light hauling. Ordinarily, they are about sixteen hands high and weigh from 1,100 to 1,350 pounds.

1. *The French Coach.*—This breed comes from that part of France known as Normandy, where it has been bred for many years. Animals of this breed have long bodies, long and arching necks, and a long, powerful stride and high knee action. The French speed their horses on sod, because they believe that travelling over such a track will develop the kind of action most desirable in a carriage horse. The color of the breed is sorrel, bay, and brown, in varying shades. This breed is widely distributed in the United States, but the total number is not large.

2. *The German Coach.*—This breed consists of several types, depending on the section of Germany from which they come, such as the Hanoverian, Oldenburg, and East Friesland horses. The Oldenburg is the heaviest type and the one most commonly imported to America. The color of the German Coach is always a bay, brown, or black. The body is heavier than that of the French Coacher. The German Coach horse nearly always has good feet. The breed is from sixteen to sixteen and a half hands high and weighs from 1,350 to 1450 pounds. There are very few pure-bred French Coach and German Coach horses raised in the United States; nearly all are imported.

3. *The Hackney.*—Hackney is a term formerly applied to a class of horses used for drawing light vehicles at considerable speed. Modern selection has developed them into a breed of heavy-harness horses. This breed was first developed in north-eastern England. The Hackney is a horse with a broad and level back, short, round body, short legs, arching neck, with head carried high—altogether a strongly-built, active animal. The Hackney is a "high-stepper," that is, the knee and hock are bent so that the feet are lifted high and

clear from the ground. His gait is not as fast as his movements suggest. The color is usually chestnut, bay, or brown with white markings. In the United States Hackneys are

42. MINNO 3577, A CHAMPION GERMAN COACH STALLION

most common in the eastern states and cities. The breed is not quite so large and heavy as the other coach breeds.

4. *The Cleveland Bay.*—The native home of the Cleveland Bay horse is in York County, England, and it is still bred there in larger numbers than elsewhere. This breed is the largest of the coach breeds, being about sixteen and one-half hands high on an average, and weighing from 1,200 to 1,500 pounds. The breed is always bay in color, with black legs,

mane, and tail. A star in the forehead and a few white hairs on the heels is all the white allowed for pure-bred animals. The Cleveland Bay has never been largely introduced into the United States, but would be a good horse for ordinary farm work as well as for carriage purposes.

The light-harness class combines great strength and rapid movement with considerably less weight than that of the heavy-harness or coach class. To the light-harness class belong trotters, pacers, and roadsters. The runners and saddlers may also be mentioned in this connection. Only one of these, the runner or thoroughbred, can be said to be so pure-bred as to be recognized as a real breed. All the others are of more or less mixed breeding.

All the types belonging to the light-harness or speed class are characterized by their long, slim necks, lank bodies, long, clean legs, and a general bony appearance. The body of a horse belonging to this class is not as round and full as that of a draft or coach horse. A cross-section back of the shoulders would be elliptical in outline. Such a deep and thin body is favorable to good lung action, so desirable for rapid movement and long endurance.

The *foundation stock* of the Thoroughbred, that is, the animals first used to start the breed, were stallions from Arabia and the Barbary States. These were mated to the native English mares. By selection from the offspring the breed was established and has been well known for about two hundred years. Fresh blood from the Orient has been frequently brought in for the improvement and maintenance of the breed. The Thoroughbred is a natural runner and in England he is much used for hunting. Such horses are called Hunters.

The *American Trotter* is a class of horses bred for racing and light driving. The breed in the beginning had a good deal of Thoroughbred blood in it The trotters are divided into families and each is named after some famous stallion who was the sire of a number of race winners. Six of the more prominent families are: * 1. The Hambletonian, named after Hambletonian 10. 2. The Mambrino, after Mambrino

43. AIKEN DILLON, A TYPICAL ROADSTER

Chief. 3. The Morgan, after a horse named Justin Morgan. 4. The Clay, after a horse called Henry Clay. 5. The Pilot, after Pilot. 6. The Hal, after Tom Hal. The last family is one of the most distinguished. Many of its members were fast pacers.

The *pacer* had about the same origin as the trotter, and about the only difference between a pacer and a trotter is the gait. Many horses both pace and trot. The pacing gait is a

* Plumb: *Types and Breeds of Farm Animals.*

faster one than the trotting. Dan Patch is at this time (1908) the fastest pacer in the world. His record is a mile in 1: 55¼.

The *roadster* is a harness type of the trotter or pacer class, somewhat heavier than is used for racing, but not as heavy as a coacher. The roadster is desirable for pulling light vehicles on the road. He is especially desired by physicians and others who have much driving to do.

The American Saddle-Horse was developed mainly in Kentucky. Because of bad roads, which made travel by horseback necessary, an easy-gaited saddle-horse was desirable. The saddle-horse had a great deal of Thoroughbred blood in his early ancestry. Many pacers were also used in the breeding-stock. A saddle-horse must have a very strong back in order to carry his rider well.

Stud Books.—Usually the men interested in a breed or class of horses meet and form a society to promote the interests of that breed. They publish a book in which are listed the names, ages, owners, descriptions, and pedigrees of their animals. A pedigree is the ancestry of the animal for several generations back. Such books are called *stud* books. When an animal has its name and description in one of these books it is said to be *registered*. Each association lays down certain rules and requirements which an animal must fulfil before it can be registered. For example, before a saddle-horse can be registered in the American Saddle-Horse Stud Book he must be able to move in five different gaits—walk, trot, rack, canter, and either running walk, fox-trot, or slow pace.

What has been said concerning the registering of horses in stud books, is also true of all other kinds and breeds of animals. Men who raise pure-bred cattle have their herd books

in which are listed and described the choice bulls and cows of the particular breed in which the breeder is interested. Each breed has its own herd book. The herd book for sheep is called a flock book. For swine the registry book is also called a herd book.

Gaits of a Saddle Horse.*—The three natural gaits of a horse are the walk, trot, and gallop or run. By training the gallop is changed into a canter, which is really only a slower movement and easier to ride. We then have the walk-trot-canter or plain-gaited horse. There are two other easier gaits—the running walk and the rack. The running walk is faster than a flat-foot walk and is an easy movement both for the horse and the rider. In it each foot strikes the ground independently. The slow pace is a kind of running walk but also resembles the pace. The two feet on each side strike the ground at almost the same time. It is a comfortable gait. The fox-trot is a slow trot or jog-trot. It is also a kind of running walk. It is a broken-time movement and is somewhat easier than the pure trot.

The trot is the diagonal gait. The off fore foot and the near hind foot strike the ground at the same instant and the horse bounds off them to hit the ground on the other two feet. This gives a two-beat gait. The pace is the lateral gait. The off forefoot and the off hindfoot hit the ground at the same time, followed by the pair on the near side. The rack is a four-beat gait. Each foot strikes the ground at a different moment and its stroke rings clear and distinct on the hard road-bed. The rack is easy for the rider but hard on the horse. The rack is sometimes called single-foot, but this term is incorrect.

* Abbreviated from *Breeder's Gazette*, June 10, 1903.

The American Saddle-Horse Breeders' Association recognizes five gaits; namely, the walk, trot, canter, rack, and the running walk or slow pace, or fox-trot. When a horse can show these five gaits he is called a *gaited* horse.

Ponies.—Horsemen are generally agreed that a horse less

44. SHETLAND PONY, GENERAL SHAFTER
A prize winner at many State Fairs

than fourteen and a quarter hands high should be called a pony. There are several breeds of ponies, most of which come from England, Wales, and Scotland.

1. *The Shetland* pony's native home is the Shetland Islands, lying north of Scotland. It is, however, bred in many other places. The Shetland pony is a small draft-horse,

being strong in body and legs. The hair is quite long, being necessarily so in the cold climate of the Shetland Islands. It ranges in height from thirty-six to forty-four inches. Shetland ponies bred in the United States and well cared for grow larger than in their native country. They are of all colors. They are used in mines in England, but in America are used almost entirely for children's pets. They are very gentle and can be safely handled by any child who does not abuse them.

2. *Other Ponies.*—The Welsh pony comes from Wales. Some are large enough to pass for horses. These ponies are quite well known and are very popular, as are also the Hackney ponies. These are really only small-sized Hackney horses. In America we have the Indian ponies, mustangs, and bronchos, which are different names for practically the same animal. The mustang and broncho are the names used in the South and West, while the others are more common in the northern states of the West. These ponies are descendants of horses brought to America by the early Spaniards. When properly treated they are very useful in their native regions. The Polo pony is simply a small horse, active and strong enough to be used for polo-playing.

The Mule.—The donkey is a distinct breed just as the horse is. It is native to Asia. A mule is a cross between a horse and a donkey. The breeding and raising of mules is extensively carried on in the United States. Missouri, Texas, Tennessee, and Kentucky are the leading states in mule-raising. St. Louis is the largest mule market in the world. It is interesting to know that George Washington was prominent as a breeder of mules and that Henry Clay introduced mule-breeding into Kentucky.

Mules differ very much in type according to the use for

which they are bred. For example, in the markets they are classed as plantation mules, cotton mules, lumber mules, railroad mules, mine mules, and levee mules, according as they are fitted to do the work in the various places.

Mules are used more extensively in the southern states than in the northern. They can stand warm weather and hard work better than horses, nor do they suffer so much from the attacks of insects and diseases. The mule is a patient, faithful, and gentle animal when sensibly treated and is useful for hard work for a long period of years.

The burro of the South-west and the Rocky Mountains is a small animal of the donkey family.

CHAPTER XXXI

FARM ANIMALS: II. CATTLE

Cattle.—Cattle existed in Europe and Asia before the ice age. Bones of cattle have been found in the ruins of the Lake-dwellers in Switzerland. Our present domesticated cattle were developed from the native cattle of Great Britain and western Europe, which in turn were brought there probably by the invading tribes from the East. The original native cattle of Great Britain are represented by the wild white cattle found on a reserve in southern England and by the Kyloes of Scotland and the Black cattle of Wales. These wild cattle are closely inbred and are being carefully protected.

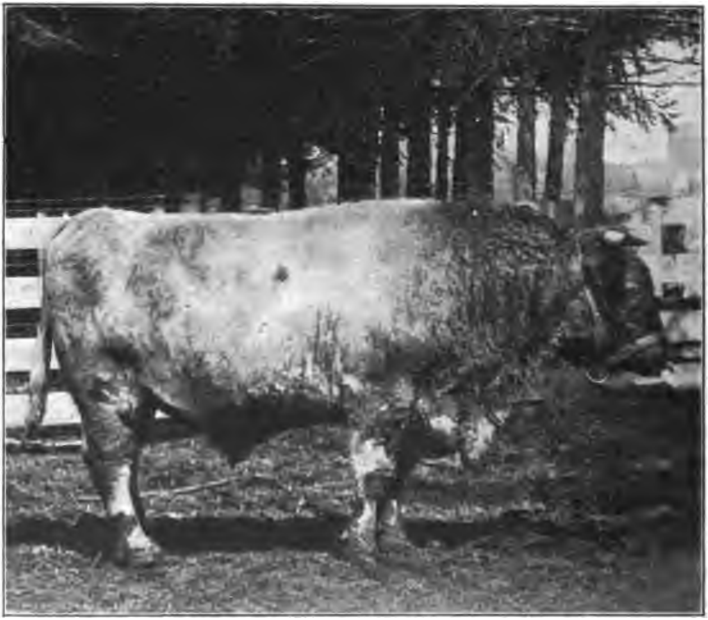
There are said to be more than one hundred different breeds of cattle.* Only a very few of these are well known or of much importance. All the breeds in America were originally brought from Great Britain or the Continent. The most important breeds are grouped into three classes: beef breeds, dairy breeds, and dual-purpose breeds.

Beef Breeds.—Beef breeds are raised primarily for their flesh-producing qualities. None but the Shorthorn gives enough milk to be profitable for milk and butter production. All beef breeds are blocky in appearance, having short legs, deep, compact bodies, thick, deep quarters, short, thick necks,

* Brooks' *Agriculture*, p. 544.

broad backs, and ribs well covered with flesh. Most breeds may be recognized by their color. The following are the principal beef breeds:

1. *Shorthorn.*—This is the largest in number of any of the beef breeds. The breed came from north-eastern Eng-



45. IMPORTED MERRY HAMPTON
A typical Shorthorn

land, where it was probably developed from cattle brought in by the early invaders of England and bred to the native cattle. They were called Shorthorn because of their short horns as compared with horns of native stock. They are also often called Durham, because of the county of Durham in which

they were largely bred. Still older names were Teeswater and Holderness. The Shorthorn was one of the first breeds to be improved. Such noted men as the Colling brothers, Thomas Bates, Thomas Booth, and Amos Cruickshank were leaders in this improvement. Some of their best animals were founders of noted Shorthorn families, such as Princess, Duchess, Wild Eyes, Cherry Blossom, Violet, and Secret. The various families produced by Thomas Bates were all heavy milk producers. The Shorthorn is equalled in weight only by the Hereford. Cows weigh about 1,600 pounds and bulls about 2,000 pounds and more. The color is red, white, combinations of red and white, and roan, never any black. Red and roan seem to be equally popular colors. The Shorthorn is nearly always gentle and easily managed.

A breed of Polled Durham cattle has been developed rather recently in America. They do not differ from the standard Shorthorn except in being hornless. However, there are two classes: 1. The "single standard which was produced by breeding native muley cows to pure-bred Shorthorn bulls. Animals of this kind of ancestry can be registered only in the Polled Durham herd book, hence the term "single standard." 2. The "double standard" came from carefully breeding Shorthorns with no horns. Animals of such pure descent can be registered in both the American Shorthorn herd book and the Polled Durham herd book. It should be understood that a herd book is the same for cattle as the stud book is for horses.

2. *Hereford.*—This breed originated in Herefordshire, England, and is said to be one of the oldest breeds in England. Because of their white faces they are sometimes called White Faces. The Hereford is shorter-legged than the Short-

horn, but is equal to it in weight. Herefords are excellent for beef, but are small milk producers, the cow giving scarcely enough to support the calf. In color they are red with white faces, and white on the throat, belly, feet, and switch. This breed is not quite so good for close confinement as the Shorthorn, but on the western plains and ranges they are superior to Shorthorns. They are good "rustlers" and can live on scant pasturage.

The first Herefords were brought to America by Henry Clay in 1817 and used in Kentucky. Herefords have be-

46. A TYPICAL SHOW HERD OF HEREFORD CATTLE

come quite popular in the states bordering the Mississippi and west of it. They have been extensively used for improving the cattle of the western ranges. They are also extensively raised on the plains of Australia, Argentina, New Zealand, and Canada. There is being developed a breed of polled Herefords which is very promising. They do not differ from the standard breed except in having no horns.

3. *Aberdeen Angus.*—This is a Scotch breed and came from the counties of Aberdeen and Angus in north-eastern Scotland. They are frequently called "doddies," which means hornless cattle. The name Angus is now mostly used. It is a very old breed, but improvement of the breed has not been going on so long as that of the Shorthorn and Hereford.

The Angus breed is black and polled. They are not quite so heavy as the Shorthorns and Herefords, but weigh very heavy in proportion to their size. Their bodies are more cylindrical than those of the other beef breeds, the skin is soft and the hair short and silky. The Angus gives a fair amount of milk, but not so much as the Shorthorns. The beef of the

47. LUCY'S PRINCE, 46181.
Typical Angus bull, three times champion of his breed at Chicago International Live Stock Shows

Angus is of superior quality. The breed stands confinement well and makes good use of feed. On the western plains they are not quite so hardy as the Herefords. They are raised mostly in the corn-belt states.

4. *Galloway.*—This is also a Scotch breed and came from south-western Scotland. It is a very old breed and not much is known of its origin. It has been bred pure for more than a century and has been hornless as far back as records go.

The Galloway is not quite so large as the other three beef breeds described. It is short-legged, rather long-bodied, always polled, and black in color. No white or other color is permitted in pure-bred animals. The hair of the coat is longer and more curly than that of the other breeds, except the West Highland. Quite often the skins are tanned and made into robes and fur coats. The beef of this breed is excellent, being as good as, or better than, that of the Angus. Galloway cows do not give much milk, although there is enough to raise the calves. The breed is hardy and stands severe climates and scant pasturage very well. For this reason the government is experimenting with Galloway cattle in Alaska. They are also being raised in large numbers on the western ranges. A few successful experiments have been made in breeding together the buffalo and the Galloway. The offspring is called a *Catalo.*

White Shorthorn bulls are often bred to Galloway and Angus cows. This breeding gives animals that are blue-gray in color and are most excellent feeders for beef production. They are commonly called "blue-grays."

5. *Other Beef Breeds.*—The West Highland breed of cattle comes from the western highlands of Scotland, where they run almost wild winter and summer. They are the hardiest of all breeds. They weigh from 900 to 1,000 pounds, are short-legged, quite blocky, and have very long, wavy hair, said sometimes to reach six inches in length. The color varies, being black, dun, yellow, or brindled. They do not give much milk and are useful only for their beef, which is excellent in quality. There are few West Highland cattle in the United States, but they might become useful in the mountain regions of the North-west and Alaska.

The Sussex cattle are an English breed and are scarcely known in the United States. They are almost as large as the Herefords and much resemble them, except that they do not have white faces. The color is solid red. They were formerly raised in England to be used as oxen.

The Longhorn breed is also an English breed, of which there are now but few left. It resembles the Shorthorn except in its extremely long horns. Robert Bakewell was one of the most famous breeders in England in his time, and he used the Longhorns in showing what could be accomplished by scientific methods.

Dairy Breeds.—The true dairy breeds are valuable mainly for their milk producing qualities. They are poor beef producers both in quality and quantity. The dairy type is entirely different from the beef type. The quarters are thin and muscular, not fleshy. The neck of the cow is thin and lean, but that of the bull is quite thick and strong. The barrel is large. This indicates an ability to handle large quantities of food, which is necessary for the production of large amounts of milk. The ribs are wide apart and less curved at the upper part than in beef breeds. The hips are quite prominent and angular. The legs are straight and placed well apart, especially the hind ones. The tail is long with a large switch. The skin of a good dairy animal is soft, a rich, waxy yellow in color, and covered with soft, short hair. The udder should be large, squarely set, and the quarters of about equal size. The teats are well placed and large enough to be easily handled in milking. The udder should extend high up behind and should be covered with soft fine hair. The milk veins, which convey blood through the udder toward the heart, show on the under side of the abdomen, and their size is an indication

of the cow's ability to give milk. The holes where they enter the abdomen near the front legs are called the "milk wells." On the whole, a good dairy animal gives the impression of being rather poor and bony.

Live stock men say that the beef animal is parallelogrammic in form; that is, any view that one may take of the animal

48. HOOD FARM POGIS 9th 55552. A TYPICAL JERSEY BULL.
By courtesy of Hood Farm, Lowell, Mass.

gives the rough outline of a rectangle, while the dairy animal shows the wedge form. The good dairy type shows a wedge form in three directions: 1. When viewed from the side, the animal is deeper behind than in front. 2. If one stands in front of the animal, it shows thicker through from side to side at the back than it does in front. 3. If looked down upon the body is thicker below than it is above.

1. *Jersey.*—Jersey cattle are more largely kept in America

than any other dairy breed. The Jersey originated in the island of Jersey, about fourteen miles from the coast of France. It is believed that they descended from the native cattle of Brittany and Normandy. Jerseys have been bred pure in the island of Jersey for two centuries. Since 1789 a law in the island has prohibited the importation of any cattle except to be slaughtered. Jersey cattle are among the smallest of the dairy breeds. The color is variable, from light yellow to black, and is usually described as fawn. The nose is usually dark-colored. In registering Jerseys the color of the tongue and the switch must be given. These may be either white or black. The Jersey is a great butter producer. She gives a considerable quantity of milk and this is very rich in butter-fat. *Butter-fat* is the very small globules of fat contained in the milk, which, when it stands, rise to the top and form the cream. It is very common for a Jersey cow to make fourteen pounds and more of butter in seven days; a few have made twenty pounds. Jersey milk is also good for cheese-making. Many competitive tests have been made in which Jerseys have competed with other breeds for butter and cheese records, and in most cases they have won. Jersey cows are usually gentle and easily handled, but the bulls are often vicious.

Professor Plumb * names the following as being ten of the most prominent Jersey families: Signal, Coomassie, Eurotas, Tormentor, St. Lambert, Golden Lad, Combination, Fontaine, Oxford, and Landseer. Jersey cattle often sell for very high prices, sales having been made for as much as $10,000 per head, while $1,000 is frequently obtained for imported animals for breeding and show purposes.

* *Types and Breeds of Farm Animals.*

2. *Guernsey.*—This breed originated on the island of Guernsey, which lies near Jersey. Like the Jersey breed, the Guernsey probably descended from the cattle of Normandy and Brittany. The Guernseys have been bred pure for many

49. DOLLY DIMPLE, 19144 ADV. R.

A typical Guernsey cow. Two-year-old record—14009 pounds milk; 703 pounds butter-fat in one year, being the world's record for age of all breeds

years on the island of Guernsey. No foreign cattle can be imported into the island. Guernsey cattle are somewhat larger than Jerseys. They resemble the Jersey very much, and unless one is familiar with them he is apt to mistake them for Jerseys. The color is yellowish, brownish, or reddish-fawn with patches of white. The reddish-fawn is most common. The nose is usually flesh-colored. The skin is a richer yellow

than that of any other breed, being especially so inside the ears and at the end of the tail. The Guernsey is about equal to the Jersey in the production of butter. Guernsey butter is a very rich yellow in color. Guernseys are not very com-

50. HOLSTEIN-FRIESIAN COW, AAGIE CORNUCOPIA PAULINE, 48426

Champion butter cow of the world from 1904 to 1907. Record—659 pounds milk, 34 pounds 5.2 ounces butter in 7 days at the age of 4 years 11 months

mon as yet in the United States, but seem to be increasing in popularity.

3. *Holstein-Friesian.*—This is a Dutch breed of cattle coming from the northern part of Holland, where it has been bred pure for nearly two thousand years. The name is derived from two provinces in Holland. This breed is found in every state in our Union and is especially numerous in the dairy districts near large cities. They are next to the Jerseys

in point of number. The Holstein-Friesian is the largest of the dairy breeds, being almost as heavy as Shorthorns, but they are not so beefy. They are always black and white in color in America, but in Holland some pure-bred herds are red and white. The calves make good veal, but the beef of mature animals is not of good quality. As producers of large quantities of milk, the Holstein-Friesian is ahead of all other breeds, but the average milk is rather low in per cent. of butter-fat, being about three per cent., while that of the Jersey and Guernsey is four and a half to five per cent. Many cows have given from 20,000 to 30,000 pounds of milk in a year, and because of this large quantity there are many butter records of twenty pounds and over per week. The butter-fat globules are small and do not separate from milk quickly upon standing. For this reason the milk is excellent for retail trade. The milk is also used largely for cheese in cheese-making districts. There are many noted families of Holstein-Friesians. Plumb mentions the following prominent ones: Aaggie, Netherland, Clothilde, Johanna, Pauline Paul, De Kol, Schuiling, and Pietertje.

4. *Ayrshire.*—This is a Scotch dairy breed coming from the county of Ayr. Its origin was from a mixture of breeds followed by careful selection. The Ayrshire is red, brown, or white, or a mixture of these colors. They are somewhat larger than Jerseys and Guernseys. In milk and butter yields they compare very well with other breeds. Their milk is especially good for cheese-making. The calves of this breed also make good veal. Ayrshires are hardy and do well on scant pasturage. In America they are found mostly in Ontario and Quebec, and in New York and the New England states.

5. *Other Dairy Breeds.*—The Dutch Belted cattle are another Dutch breed, having been bred pure for many years by the aristocracy of Holland. They got their name from a band of white which encircles the barrel back of the shoulders and

51. A GROUP OF DUTCH BELTED CATTLE IN PASTURE

in front of the hips. The remainder of the body is black. They are not so large as the Holstein-Friesians, but in general resemble them in characteristics. There are few of this breed in America.

The Kerry cattle are an Irish breed and the Kerry cow is famous as the "poor man's cow." This is the smallest of dairy breeds, forty inches being a common height. The color

is mostly black with a line of white along the back and also under the belly. The Kerry cow is a wonderful milk producer for her size and the small amount of feed which she gets. There are very few Kerries in the United States.

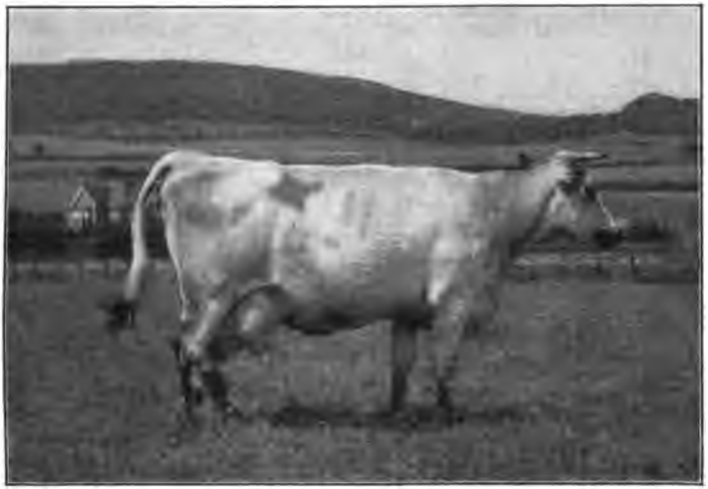
The French-Canadian is an American breed, descended from the cattle brought by the first French settlers in Quebec. The breed very much resembles the Jersey. The color is usually black. They are excellent milk producers and are very hardy. They are bred almost entirely in the province of Quebec.

Dual-Purpose Breeds.—By a dual-purpose or general-purpose breed is meant one which is both a good milk producer and a good beef producer There is quite a demand from farmers for cattle which will give a fair quantity of milk and will also produce calves which sell well as veals or will grow into good beef animals. The dual-purpose type is not so large and massive as the beef type nor so lean and angular as the dairy type. There are several breeds classed as dual-purpose breeds, but in any of these breeds both beef and milking types are to be found.

1. *Shorthorn.*—As was mentioned on page 229, some families of Shorthorns are noted for their milk production. This is especially true of the Bates families. The Polled Durham breeders are trying to make that breed a strictly dual-purpose one.

2. *Devon.*—This is a very old English breed, being spoken of by the earliest writers. Its native home is in the counties of Devon and Somerset, in England. The Devons vary in size, some types being larger than others. The larger, coarser types are usually better milk producers than the smaller, trimmer types, which are better for beef. Devon

milk ranks with Jersey milk in quality and is also abundant in quantity. Devon cows fatten fairly well and produce beef of excellent quality. In color, they are usually cherry red with no white, unless it be on the udder. The horns of the cow are long and slender and turn up with graceful curves.



52. ENGLISH SHORTHORN COW, TULIP LEAF, OWNED BY LORD ROTHSCHILD, TRING PARK, ENGLAND

Record—10,502 pounds of milk in one year when 11 years old. She is a good specimen of the dual-purpose breeds

The bull's horns grow out at right angles to the head and are stout and only slightly turned up. This breed is found mostly in New England and Ohio.

3. *Red Polled.*—This is the truest dual-purpose breed. It originated in the counties of Norfolk and Suffolk, England. All animals are polled, and solid red is the preferred color, although white may occur on the switch, udder, or belly. They are larger than Devons but smaller than Shorthorns,

males weighing about 1,800 pounds and females 1,250 pounds. They give a large quantity of milk of fair quality. One of their faults is poorly shaped udders and extremely large teats. The steers fatten well and the cows, after they have ceased to give milk, fatten quickly. The beef is of very good quality. The Red Polled breed is not numerous in the United States, but is becoming more and more popular.

4. *Brown Swiss.*—In Switzerland we have some of the oldest records of cattle, their remains being found in the débris of the Lake-dwellers. There are two distinct breeds in Switzerland of about equal importance. One of these, called the Simmenthal, is cream yellow and white in color. Practically none of this breed has been brought to America. The other breed is known as the Brown Swiss and a few herds are to be found in the United States. They range from dark brown to light brown in color, shading to gray along the backbone. The udder is usually white. They are a rather coarse-boned and rough-framed cattle. In weight they are about like the Red Polled. Both breeds of Swiss cattle are famous in their native country for their milk, which produces large quantities of butter and cheese.

CHAPTER XXXII

FARM ANIMALS: III. SHEEP AND GOATS

SHEEP-RAISING has been an occupation for a longer time than history records. In early times sheep were raised more for their wool and milk than for their flesh. Wool was made into cloth in Asia at least 2,000 years before Christ.

Sheep wild by nature live in mountainous regions and are still found in mountainous parts of both the Old World and the New. In North America we have in the Rocky Mountains the Bighorn and the Alaskan sheep. In South America we find the Vicuna, Llama, and Alpaca. These last are closely related to the sheep. All our domestic sheep originated in the Old World, but it is not known whether they are descended from some of the present wild sheep or whether they came from a race of sheep now extinct. Sheep were brought to America by the earliest colonists.

The various breeds of sheep are usually classed as fine-wooled, medium-wooled, or coarse-wooled sheep. They are also often classed as mutton or as wool breeds, but a breed good for mutton production also produces wool of value, so it seems better to classify according to the wool. The coarse-wooled and medium-wooled breeds are known as the mutton breeds. The essentials for a mutton sheep are the same as for a beef animal, namely, a square, blocky form well filled out in all parts. The coarse-wooled breeds are the Leicester

(pronounced Lĕs′ter), the Lincoln, and the Cotswold. Of these the Cotswold is the most important in the United States.

The *Cotswold* sheep originated in Gloucestershire, England. The name is a combination of "cots," meaning sheds, and "weald," or "wold," meaning naked, hilly ground. The

53. A TYPICAL COTSWOLD

breed has been much improved by careful breeding and selection. The breed is one of the largest, being equalled in size by the Lincoln only. The rams weigh about 250 to 275 pounds. These sheep have rather long legs, large, strong bodies, and a long wool which is in locks more or less curly. Several locks hang over the forehead, and this is rather a distinguishing mark. The face is white, the nose Roman, and there are no horns.

The Cotswold is a good wool producer. The fleece will average ten pounds in weight and the staple is often twelve to fourteen inches in length, but is rather coarse. The word *staple* refers to the fibres of wool. The mutton of this breed is only fair in quality, the fat not being well distributed through the lean meat. Lambs less than twelve months old make the best mutton.

This breed is widely distributed, but the total number is not so large as that of some other breeds. In America the leading flocks are in Ohio, Michigan, Wisconsin, and Ontario.

The *Leicester* breed comes from Leicestershire in central England. It was one of the first breeds to be improved. Robert Bakewell made himself famous by his improvement of it. It has been much used for crossing for the improvement of other breeds. The mutton is much like that of the Cotswold, but the wool has a much finer fibre and does not lie in curls. The head is bare of wool and there are no horns. While this breed is widely distributed, the total number of animals is not large.

The *Lincoln* is also an English breed, coming from the county of Lincoln. It is the largest of our breeds of sheep. Rams sometimes weigh 400 pounds, but 300 pounds is an average weight. The wool hangs in curls somewhat like the fleece of the Cotswold and there is a short forelock. The staple is longer than that of any other breed, being reported as long as twenty-one inches. The average weight of the fleece is about fifteen pounds. The mutton is much the same as that of the Cotswold. The breed is also widely distributed but nowhere very numerous. Rams of this breed are being extensively used for breeding purposes in Argentina, and the lambs

are sold in English markets. High prices have been realized for rams for use in Argentina, one being sold for $7,600.

The medium-wooled breeds are represented by the Shropshire, Southdown, Dorset, Cheviot, Hampshire, Oxford,

54. A SHROPSHIRE, AN EXCELLENT SPECIMEN OF THE MUTTON AND WOOL TYPE

Note the blocky, compact form

Tunis, and Suffolk. The Shropshires, Southdowns, Hampshires, Oxfords, and Suffolks are known as the Down breeds.

As a pure breed, the *Shropshire* is not very old. Its native home is in the counties of Shropshire and Stafford, England. It is said that the original Shropshire was horned, black or brown faced, produced about two and a half pounds of wool at a shearing, and dressed about forty pounds of mutton when

slaughtered. Several breeds were used in the early improvement of Shropshire sheep, but for many years they have been bred pure.

The face, ears, and legs of Shropshires are usually black or dark brown. The face is usually almost entirely covered with wool, this being a distinguishing mark. They have no horns. Sheep of this breed are above medium size, rams averaging about 225 pounds and ewes 160 pounds. The wool is distributed over the body evenly and close. The fleece will average ten to twelve pounds in weight, and is medium fine in quality. The mutton of the Shropshire is excellent in quality and large in quantity.

Although Shropshires were not imported into the United States until about 1860, they are now probably more numerous than any other breed. Several things have tended to make them popular with farmers and sheep-raisers: (1) Their general-purpose character, being good producers of both wool and mutton; (2) the ewes often give birth to two lambs, so that the shepherd's flock increases rapidly in number; (3) they are useful for improving native sheep; (4) the lambs mature early, that is, are soon ready for market.

The *Southdown* originally came from south-eastern England. In that region there is a range of low, chalky hills called the South Downs and from these the breed takes its name. The improvement of the breed was begun long ago. Many English noblemen have been noted as breeders of Southdown sheep; even King Edward VII has a fine flock.

The Southdown is the smallest of the English breeds that have been brought to America, rams weighing 175 pounds and ewes 135 pounds. The face, ears, and legs are grayish-brown or reddish-brown, always lighter-colored than Shrop-

shires. The face is not so completely covered with wool, nor is that on the forehead and top of the head so long as in the case of Shropshires. The body is rounded and plump. The wool is rather short but of fine quality. Fleeces average about seven pounds. The mutton is of the best quality, being tender, juicy, well-flavored, and fine-grained. The lambs mature quickly and sell well on the market. Southdowns are found everywhere, but their number is not so large as that of Shropshires.

The county of Hampshire, in England, is the native home of the *Hampshire* breed. The breed has been developed within the last century. It is one of the largest of the middle-wool breeds. In a general way it resembles the Shropshire, but is larger, coarser-boned, and does not produce so much wool, nor is it of such good quality. The head is larger than that of the Shropshire, and the face is not so completely covered with wool. The face, ears, lips, and legs are dark brown or black in color. The nose is Roman and quite prominent. The mutton is excellent in quality, but smaller in quantity in proportion to total weight than in the Southdown or Shropshire breeds, owing to the larger bones. Hampshire lambs mature early and are good sellers. This breed is not numerous in the United States.

The *Oxford* breed of sheep is of rather recent origin. It was originated in the county of Oxford, England, by the breeding together of Cotswold and Hampshire stock. The breed has become quite popular, owing to several good qualities. Of these its large size is most prized. It is the largest of the middle-wool breeds and almost equals the coarse-wool breeds. It produces a heavy weight of excellent mutton and shears a heavy fleece of coarse wool. The lambs do not ma-

ture quite so early as those of some other breeds, but become heavier. The Oxfords are widely distributed and are increasing in numbers.

The *Suffolk* sheep is scarcely known in America. Its native home is in the counties of Suffolk, Norfolk, and adjoining counties in England. The Suffolk is a large breed very much resembling the Hampshire. The head, face, ears, and legs are black. The head has no horns and the wool extends only to the poll. They shear a good fleece and the mutton is said to be excellent.

Tunis sheep were brought to America from Tunis, Africa, in 1799. Only one pair survived the voyage, and Professor Shaw* says that these were the ancestors of all the Tunis sheep now in America. This breed averages about 150 pounds in weight. The color varies, but is usually gray. It is never pure white. The mutton is excellent and the fleece of good quality. The ewes are quite prolific, often producing two lambs at a time and frequently bearing young twice a year. There are very few Tunis sheep in America, and those principally in Indiana, Ohio, and South Carolina.

The *Dorset Horn* is an English breed of sheep not well known in America. Both the ram and ewe have horns; those of the ram curve spirally, while those of the ewe curve outward, downward, and forward. The face, legs, and hoofs are white and there is a short foretop. In mutton and wool production they compare favorably with other breeds. Their main strong point is for the production of early market lambs. The ewes will breed at almost any season of the year and the grower can have lambs for market at any time.

The border-land between England and Scotland in the

* *Study of Breeds*. p. 211.

vicinity of the Cheviot Hills is the native home of the *Cheviot* breed of sheep. No one knows of their earliest origin. This breed is suited to hilly regions and is quite hardy, enduring well severe weather. It is about as large as the Shropshire. The nostrils, lips, and hoofs are black; the head, ears, and legs white. The wool is of medium quality and ordinary in

55. DORSET HORN SHEEP

quantity, and the mutton is good in quality. The number of Cheviots in the United States is not large, the largest number being in Indiana and New York.

The various *Merino* breeds represent the fine-wooled sheep. The Merino stands in about the same relation to other breeds of sheep as a dairy breed of cattle does to other breeds. The Merino is mainly a wool producing sheep. The fibre of its wool is the finest of all wools. The mutton of Merino breeds is not high grade either in quality or quantity. The fleece

of all Merinos is very oily, owing to the large quantity of *yolk*, an oily secretion which comes from glands located at the root of the wool fibre. This oil passes along the wool fibre to its end, where it catches a great deal of dust and dirt and is also darkened in color by the sun. This explains why Merino sheep always look so dirty. Other breeds of sheep also have yolk in their wool, but it is usually small in quantity. The form of the Merino is not so plump, square, and blocky as that of the breeds already described. Its neck and legs have the appearance of being long. Owing to a thin chest, the legs often stand too close together in front. The skin is loose and is gathered into large wrinkles or folds, especially on the neck.

All Merino breeds originated in Spain. Here sheep-raising was an important industry for many centuries, but is not so any more. Nothing is known of the beginning of sheep-husbandry in Spain. There were many types of Merinos there, and from them the various Merino breeds throughout the world have been developed. In the United States we have the American Merino and the Rambouillet.

The American Merino was developed from the Spanish breeds. Merinos were first brought to the United States from Spain about 1793. Since that time many Merinos have been imported from Spain, and much has been done by selection and careful feeding to improve the breed. The American Merino has heavy folds of skin all over its body except on the back. The rams have horns, but the ewes have none. The entire body and legs are covered with wool. The nose, ears, and lower part of the head are not covered with wool. The quantity of yolk, or oil, in the wool is so great that when fleeces are scoured a very large shrinkage in weight, often as

much as fifty per cent. or more, takes place. Merinos are not large, rams weighing 130 pounds or more and ewes about 120 pounds. Many American Merinos shear a fleece which is twenty-five per cent. or more of the total weight of the animal. The fibre is quite fine, that of the ewes being finer than that of the rams. American Merino lambs mature slowly and the mutton is poor in quality.

56. A RAMBOUILLET SHEEP

Notice that the form is less smooth and compact than in the mutton type

From the American Merino have been developed several types or families. The most noted of these is the *Delaine*, so called because its wool is of the type formerly used for making a kind of cloth known as *delaine*. There are several families of Delaine, among which are the Dickinson Delaine, National Delaine, Victor-Beall Delaine, Black-Top Spanish, and Improved Black-Top Merino. The Delaines have fewer wrinkles than the American Merino, most of them being on the neck and lower part of the belly. The Delaine is somewhat larger than the American Merino and is somewhat better for mutton.

The *Rambouillet* (Răm′bōō yā′) Merino comes from France where it was developed from stock taken from Spain. It has also been called the French Merino, but the name Ram-

bouillet is now more used. This breed is much larger than the other Merino breeds and has fewer wrinkles, some specimens having scarcely any except on the neck. The nose and ears are covered with fine wool. The legs are clothed with wool to the toes. The fleece is usually not so oily as that of

57. WENSLEYDALE EWES IN PASTURE
This is becoming a very popular breed in England

other Merinos, owing to a somewhat smaller amount of oil. The rams have horns, but the ewes are hornless. The Rambouillet is a fair mutton producer and the lambs mature fairly early. The breed is quite hardy and is being much used on the western ranges.

Other breeds of sheep scarcely known in America are: (1) The Kent or Romney Marsh, a breed adapted to the low,

swampy regions of south-eastern England; (2) The Black-Faced Highland, a breed from Scotland, adapted to mountainous regions; and (3) the Wensleydales, a breed from the north of England.

Goats.—The raising of goats is becoming more and more general in the United States, and this is particularly true

58. ANGORA GOATS

where the land is too rough for grain-raising. There are two main classes of goats; namely, those which are raised principally for their fleece and those raised for their milk. Only the first class is raised to any extent in the United States.

The *Angora* goat is the one raised for its fleece, which is called *mohair*. Mohair is coarser than sheep's wool, and is longer and much stronger. Angora goats were first brought

to America from Turkey in 1849. Perhaps the original home of the Angora is in central Asia. The goat is smaller than the average sheep, weighing 60 to 100 pounds. The mohair grows eight to ten inches long, or more, in a year and hangs in curls all over the body. The fleece is shed in the spring if it is not shorn. Underneath the mohair is a short coat of hair called *kemp*. Sometimes it becomes three or four inches long and gets mixed with the mohair in shearing. Kemp in the mohair spoils the sale. Angora mutton, especially that from young Angoras, is said to be very good. Sometimes, however, it has a musky odor. It is not often found in the market as yet. Angoras are very useful on brushy land, as they seem to prefer twigs and leaves to grass. A flock of Angoras soon clean a piece of land of all brush and small trees. Angoras are found in almost every state in the Union, but the largest flocks are in New Mexico and Texas.

The use of goats for milch animals is very old. The oldest records make mention of their use. The milk of the goat is quite white in color. The flavor is sometimes musky, but when the goats are kept in clean quarters and the females separate from the males, there is no unpleasant odor.

There are several breeds of milch goats, but none has become common in America. The *common* goat is more frequently found than any other and it is not a famous milk producer. Among the best breeds for milk are: (1) the Maltese from the island of Malta; (2) the Toggenburg and Saanen from Switzerland; and (3) the Nubian goat found in Nubia, Egypt, and South Africa. When carefully cared for the does give milk for several months, about five months being the average. The amount of milk given varies greatly with the breed and with individuals. The Nubian seems to be the

largest milk producer, some of the does giving as much as ten or twelve quarts per day. Other breeds give four to six quarts, and three to four quarts per day is about an average for all the milch breeds.

CHAPTER XXXIII

FARM ANIMALS: IV. SWINE

Swine.—Our domestic swine have been developed from the wild hogs of Europe and Asia. There are two species of these, but they are not far different. Wild hogs have been known since the beginning of history. Hunting the wild boar is one of the oldest of sports and is still continued in Europe. A kind of wild pig called the peccary is found in America, ranging from Arkansas, Texas, and Mexico to Patagonia. The change from the wild state to a domestic one has made a great change in swine. The wild hog requires three or four years to become fully grown, while the tame hog is fully developed in half the time. The wild hog never became very fat, but our present-day pigs may become excessively fat at an early age. Our domestic pigs are slow in action and rarely ferocious, while the wild hog is quick, active, and very fierce.

The various breeds of hogs have been classified in three ways: (1) red, white, and black breeds; (2) large, medium, and small breeds; (3) lard and bacon breeds. We shall use the latter classification. The *lard or fat type* of hog has short legs, compact, blocky body, with short sides, quite wide on the back, short neck, small head, large hams and shoulders. There is much fat formed under the skin and around the kidneys. The large layer of fat formed around the kidneys is called *leaf lard* and is the best in quality. The short sides are

almost a mass of fat with very little lean meat. It is the sides when cured that produce the *breakfast bacon.* The lard type of hog does not give the best breakfast bacon because of the large quantity of fat and small amount of lean. The *bacon* type of hog is almost the opposite of the lard type. It is long-

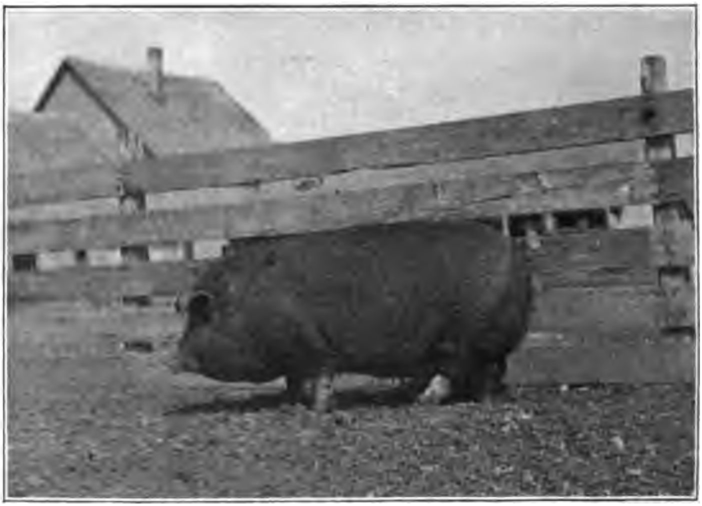
59. A TYPICAL BERKSHIRE
By courtesy of A. J. Lovejoy & Son, Roscoe, Ill.

legged, narrow on the back, rather small in the shoulders and hams, long and deep in the sides, has a large, coarse head, and rather long neck. The bacon type never gets so fat and lubberly as the lard type. The long, deep sides have a good quantity of lean flesh mixed with the fat, and this produces the delicious bacon of which most persons are very fond.

The Lard Type.—*The Berkshire.*—This is an English breed from the counties of Berkshire and Wilts. In its early improvement Chinese, Siamese, and Neapolitan breeds were used, but later improvements were mainly by careful selection. The Berkshire is one of the larger breeds. Young pigs at six months old may easily be made to weigh 180 pounds or more. The color is black, with "six white points"; namely, white in the face, white on the tail, and four white feet. There are sometimes other white marks, but the six mentioned are almost always present. The earlier Berkshires were often sandy or even red in color. The Berkshire usually carries its ears erect, and this helps to distinguish it from the Poland-China whose ears always droop more or less. The pork of the Berkshire is superior. A large proportion of the flesh is lean and the fat is well intermingled. This breed can be made to pass for a bacon type when properly fed. Berkshires have been largely used in improving other breeds and in grading up the common breeds. The Berkshire is adapted to a wide range of climate, but is best adapted to temperate regions. It is probably more widely distributed in the United States than any other breed. Large prices have been paid for breeding stock of this breed, boars often selling for $1,000 or more.

Poland-China.—The Poland-China is an American breed originating in Butler and Warren Counties, Ohio. It was developed from a mixture of several local breeds. These breeds were the Russian, Byfield, Big China, Irish Grazier, and Berkshire, and probably some others, but since 1845 it has been pure. The breed was mostly white in color until the Berkshire blood was introduced, after which black with white in the face, on the tail, and white feet became the

common color. White spots also often occur on various parts of the body. The origin of the name Poland-China cannot be satisfactorily accounted for. Poland-Chinas are not quite so large as Berkshires, but the pigs will mature earlier. The pork is much criticised because of the large amount of



60. NORA P., 160,484, A TYPICAL POLAND-CHINA
Owned by Purdue University
Photo by C. N. Arnett, Purdue University

fat. This breed seems to be well adapted to crossing on common sows. More grade Poland-Chinas than any other are brought to the Chicago market. By *cross-breeding* is meant the mating of a male of one breed with a female of a different breed. The Poland-China breed is confined largely to the Mississippi Valley. It is scarcely known in foreign countries. Larger prices have been paid for breeding stock of this breed than for any other. Poland-Chinas can be distinguished from

Berkshires mainly by their drooping ears, smaller and less turned up noses.

Duroc-Jersey.—This is also a breed of American origin. As to its beginning, breeders do not agree, but it is believed that the Duroc-Jersey is the result of the mingling of several red breeds of hogs. Fifty years ago there were several red breeds, among which were: (1) the Guinea breed, introduced from Africa; (2) the Portuguese, red hogs imported from Portugal by Daniel Webster; (3) Spanish red pigs, imported from Spain by Henry Clay; (4) Jersey Reds, a breed common in New Jersey; (5) Duroc, a red breed founded in Saratoga County, New York; and (6) Red Berkshires, in Connecticut. It is probable that the Durocs, Jersey Reds, and Red Berkshires had most to do with the origin of the present breed.

Duroc-Jerseys have much the same build as the Poland-Chinas. They are broad-backed, have rather small heads, large, drooping ears, heavy shoulders and hams, and are rather coarse-boned. The color is always red with varying shades. In size they are between the Berkshire and Poland-China, and often equal the Berkshire. Duroc-Jersey pigs mature early and sell well on the market. The pork is of good quality, but perhaps not quite so good as that of the Berkshire. The breed is confined mainly to the central states in the corn-belt, but is rapidly growing in favor everywhere, owing to its hardiness, early maturing qualities, and the large litters produced.

Chester White.—The Chester White is another American breed, originating in Chester County, Pennsylvania. White hogs had been raised there since the time of the earliest colonists, and when their improvement began it was natural to give the name of the county to the breed. Perhaps more has been done in Ohio to improve the breed

than elsewhere. The Ohio Improved Chester (O. I. C.) Whites are from this source. The Chester White is one of the largest breeds. Before improvement was carried to its present perfection, animals weighing 1,000 pounds were not uncommon. At present mature animals weigh 450 to 600 pounds. This breed is one of the most profitable to raise, since it makes large gains on a small amount of feed. The

61. STARK-ADVANCE, 23,477
Chester White

pork is of fair quality, containing rather too much fat for the lean. In color this breed, of course, is white, but sometimes there are black spots on the skin under the hair. The ears are large and drooping, the back broad, the body deep, and the legs short. The breed is widely distributed, especially in the states north of the latitude of the Ohio River, and is popular on account of its early maturing qualities, good size, and prolificacy.

Cheshire.—This breed is also American, originating in

Jefferson County, New York. It is a rather new breed and is little known except in New York and New England. It is medium in size, of white color, has small, pointed, and erect ears, a long body and rather long legs. The pork is said to be of fine quality, possessing a large proportion of lean which makes it rather a bacon type.

Victoria.—This is still another American breed and had two distinct places of origin. One was in New York where Col. F. D. Curtis was the originator. His breed is no longer bred pure. The other place of origin was in Lake County, Indiana, where Mr. Geo. F. Davis was the originator. Mr. Davis started the breed by breeding together Poland-Chinas, Berkshires, Chester Whites, and Suffolks and then making careful selections. This work was begun about 1870. The breed is too young to have a well-established standing, but it has been successfully exhibited at many fairs and at the Chicago Fat Stock Show. Victorias are about the size of Poland-Chinas, white in color, with occasional black spots on the skin. The pork is of good quality. One advantage claimed for the breed is that it is less liable to skin diseases than other breeds of white hogs. It is confined principally to Indiana, Ohio, and Illinois.

Essex.—This breed is from the county of Essex, England. It is one of the smaller breeds and is not well known in the United States. It is totally black, the ears are short and erect, the body short and chunky, the back rather broad and the legs rather short. The pigs mature early and can be fattened at almost any time. The pork is of good quality but has rather too much fat. Essex swine are particularly adapted to keeping in pens and small lots.

Small Yorkshire.—This is also an English breed and one

of the smallest in size. It is white, short, and thick, has a small head, a face so much dished that the nose turns up, and short, erect ears. Small Yorkshires mature very early and are ready for market at almost any age. The pork is tender and juicy but has too much fat. The breed is not well known in the United States.

Suffolk.—This breed is also of English origin and is probably only a variation from the Small Yorkshire, at least the two have a very close resemblance. In England there is a breed of black swine which is called the Suffolk, but in America the breed is white in color. There are but few herds in the United States.

The Bacon Type.—*Large Yorkshire.*—It is probable that this breed has descended from the original English stock. Other breeds have been little used in its improvement. The Yorkshire is one of the largest breeds, mature animals often weighing 1,000 pounds. The head is long with a very long snout, and large and somewhat drooping ears, the back is not very wide, the sides rather long and deep, legs long, and hams and shoulders neat and light. The color is entirely white. Yorkshires do not get their growth so early as most of the fat breeds, but pigs may be marketed in good form at six to nine months. However, they never become very fat. The pork is excellent, having a large percentage of lean meat, just the kind demanded by the English market. For bacon production this breed is growing in popularity, although in the corn-belt farmers mostly prefer the lard type of hog. The Large Yorkshire is not yet very common in the United States, but is numerous in Canada. There is a variation of this breed in England called the Middle White Yorkshire.

Tamworth.—This breed is said to be one of the oldest and

purest breeds in England. Its improvement has been almost entirely by careful selection. The Tamworth equals the Large Yorkshire in size. It is distinctly of the bacon type and the pork is excellent, but the Yorkshire seems to be more popular. The Tamworth is wholly red in color. The head, body, and legs are long. The pigs, as a rule, do not mature as quickly as those of other breeds. Both the Tam-

62. SUMMER HILL COLSTON ECLIPSE 2ND, 4,232
The large Yorkshire, a type of the bacon breeds. Note the long deep sides

worth and Large Yorkshire are noted for their prolificacy, litters of ten and more being very common. There are many herds of Tamworth hogs in America, especially west of the Mississippi.

Hampshire.—The origin of this breed is not certainly known, but it is probably English. The breed is mainly raised in Kentucky. It is of the bacon type and the pork is excellent. The color is black with a belt of white encircling the body just back of and including the front legs. Some animals are entirely black. The Hampshire is medium in size.

Chinese and Neapolitan Swine.—These breeds are not found in this country at the present time. Years ago they were more or less used in improving the other breeds, both in England and in America. Both breeds were rather small in size. The Neapolitan was slate or bluish plum-colored. The Chinese was white in color, the back swayed, and the legs short.

CHAPTER XXXIV

THE BREEDING OF LIVE STOCK

Selecting the Animals.—Almost every farmer keeps some animals, and in almost every case he raises some young animals either to take the place of the older ones or to sell. The growing of young stock either for home use or for market is the purpose in *stock-breeding*.

When one begins to raise young animals he should have mature animals with which to begin. These are his *foundation stock*. The male is called the *sire*, the female, the *dam*. The choice of foundation stock is not always wisely made. It is desirable that it should consist of animals of as good breeding as possible. They should also be of good form and appearance, and be suited to the purpose of the breeder. Well-bred animals should be chosen for foundation stock for at least three reasons: 1. The offspring will bring better prices because they look better, and, if sold for slaughter, will dress out a larger percentage of meat than animals of poor breeding. 2. The offspring will mature more quickly than those of animals of poor breeding. 3. Well-bred animals eat less food in proportion to the gains they make.

The term *well-bred* is used in two ways: (1) when an animal has a large percentage of pure blood and is of superior quality; (2) when the animal has a long ancestry of pure blood and excellent quality. It is *pure-bred* when its dam

and sire are free from mixture with other breeds. For example, a Shorthorn calf is pure-bred if its dam and sire were both pure Shorthorns, that is, had no Angus or Hereford or Red Polled blood, or the blood of any other breed, in them. The terms *full blood* and *thoroughbred* are not good terms to use when speaking of animals of pure breeding. An animal is called a *grade* when only one of its parents has been pure-bred. When both dam and sire are of mixed breeding the offspring is a *scrub* or *native*. When two animals of pure blood but of different breed are bred together the offspring is a *cross*.

The choice of a sire is more important than the choice of a dam, because he is used for mating to all the females of the herd. It is a common saying that the sire is half of the herd. This is true because each offspring is influenced in half or more of its qualities by the characteristics of the sire. When a breeder uses a pure-bred male with females of impure breeding, with the purpose of improving his stock, he is said to be *grading up* his herd. If a pure-bred male is used again with the females of this offspring, the improvement will be further increased in the second lot of offspring, and the grades become more nearly pure-bred. If a scrub female is mated to a pure-bred male the offspring is a half blood. If this half blood be a female and be mated to a pure-bred male the offspring will be a three-quarter blood, for the offspring will derive one half of its quality from the male, which is pure, and the other half will come from the female, one-half of which is pure; that is, there is one-fourth of pure blood derived from the dam. One-fourth and one-half are three-quarters, hence the offspring from the half-blood female and the pure-blood male is three-quarters pure. A third such cross will

give an animal which is seven-eighths pure, a fourth cross an animal fifteen-sixteenths pure, and so on.

By following out the foregoing principles it is clear that in a very few generations the offspring will have a very small fraction of the original scrub blood in it. But according to the rules of live-stock record associations in the United States animals of such parentage can never be registered as of pure blood. If one wishes to have pure-bred animals there are now so many such animals to be had at reasonable prices that it is not advisable to go through the long process of grading up to get them. However, the use of pure-bred males is always to be advised for grading up.

When one purchases pure-bred animals for starting a herd he should give some attention to their pedigrees. A pedigree is a statement of the ancestors of an animal. It gives the name of the animal and its herd-book number, a description of its color, tells its sex, the name of its owner and breeder, and the date of its birth. Then follow the names of its sire and dam, with their herd-book numbers, and sometimes the grand-sires and grand-dams, running back several generations. One who is purchasing stock with pedigrees should seek to know something about the individual quality of the animals in the ancestry, for while they may have been pure-bred they may also have been poor specimens of the breed. This is especially true of dairy animals. A dairy cow may be of the purest breeding and yet be a poor producer of milk and butter-fat.

In selecting foundation stock it is best to choose mature animals or at least animals which have already produced young. The mature animal has its form fully developed, so that there is less danger of getting an animal of poor form. If a sire has already produced progeny one can form some

idea of his value as a breeder. Likewise, we can know something of the quality of the dam. Young and untried animals may prove a disappointment. However, it is not advisable to select animals too old, for if they have gone past their prime their offspring may not have the strength and vitality that it should. Moreover, old animals cannot be used very long, so that the herd will not increase very much from their blood.

It is also desirable that animals used for breeding should be in good health and free from defects in body. Animals suffering from disease are likely to produce weak, puny, and undersized offspring. Moreover, animals having defects in form are likely to impart the defects to their offspring; that is, the young will inherit defects from their parents. None but superior animals of good breeding should be used for breeding purposes.

A very important item in successful breeding of live stock is the care given the animals used for breeding. One may have breeding stock of the best quality, but with careless treatment it will give very poor returns. 1. Breeding animals should be properly fed. Sufficient food and food of good quality is necessary to keep the parents strong and healthy and insure vigorous offspring. Musty, mouldy, rotten, or dusty food should not be fed to animals intended for breeding purposes. Live stock relish clean, sweet, pure food as much as human beings do. 2. What has been said concerning food applies also to the water which animals have to drink. Clean and pure water, about 50° F. in temperature, is as important for animals as it is for man. The fact that a hog will wallow in the mud is no sign that clean water is not best for it to drink. 3. Clean and comfortable barns and sheds are desirable for winter and cool, shady places for summer. Artificially warm

buildings are not desirable for live stock, for they have sufficient covering of hair to keep their bodies warm; but they should be kept dry and protected from the cold rains and chilly winds of winter and spring. 4. Exercise is necessary, especially for breeding animals. Exercise is nature's method of keeping the body vigorous. Animals should be in the open air in summer and be turned out in good weather during the winter.

Good ventilation is also necessary when animals are stabled. To get such ventilation without having drafts of air over the animals, many stockmen are using muslin tacked over the windows instead of glass in the sash. The muslin permits an exchange of atmosphere but prevents drafts.

CHAPTER XXXV

SOME TERMS USED IN LIVE STOCK BREEDING

In the breeding of live stock there are many terms and expressions used by stockmen which are not well understood by persons not engaged in such work. A few of these expressions will be briefly explained in this chapter.

Heredity.—It is a common saying that like begets like, by which is meant that the offspring will inherit the qualities of the parents. If they are good animals and of good breeding the offspring is likely to be a good animal also. For example, if the sire or dam has a spavin, the colt will inherit a weak hock which will make probable the development of a spavin in it; or if one or both of the parents are vicious, the offspring will probably show the same characteristics. We may say, then, that heredity refers to the passing on to the offspring of qualities possessed by the parents.

Atavism.—This means a tendency for the offspring to be like the earlier types of the breed. It is best explained by an example. Angus cattle are now black in color, but in the earlier history of the breed many animals were red. It sometimes happens that in pure-bred Angus herds a calf is born which is red in color, thus reverting to the earlier type. The same thing frequently occurs in Berkshire hogs. Pigs are farrowed with red hair in their coats, which doubtless comes from the color of earlier types. These examples serve

to illustrate atavism. The term *reversion* refers to a resemblance of the offspring to rather recent ancestors. A very striking case of atavism, and one hard to explain, is often called a "sport"; for example, a calf white in color was born of pure-bred Galloway parents at Brookside Farm, Fort Wayne, Ind. Since Galloways have shown no other color than black for centuries, this was a most extraordinary event.

Variation.—It is impossible for the offspring to be like both parents. It will have some of the characteristics of both, but will be more or less unlike either. This varying from the characteristics of the parents is called *variation.* It is well understood by stockmen that no two animals are exactly alike. Because of these variations it is possible for the stockman to make selections for improving his animals.

Correlation.—When the body is greatly developed in some particular part, some other part will be less developed than it should be, or else be modified in some way. As swine have increased their tendency to become fat the nose has become shorter. The dairy cow giving larger quantities of milk is always lean. The draft horse with his large muscles and strong bones is always slow in moving. All these are examples of correlation. The student desiring to know more about the principles of breeding should consult books written especially on the subject. It is a most interesting study.

CHAPTER XXXVI

THE FEEDING OF ANIMALS

THE COMPOSITION AND USES OF FEEDS

THE farmer who raises animals needs to know how to feed them properly. Just as he needs to know the kind of soil to which a plant is adapted and the right kind and amounts of manure and fertilizer to apply to the land to make the plant grow properly, so does he need to know the composition of the various feeds and what effect they will have on these animals when fed to them. In the food fed to animals are found the elements necessary for the production of blood, bone, muscle, fat, milk, wool, and tissues of all kinds. When combined with the oxygen of the air, heat to keep the body warm and energy for moving it are also supplied by the food.

As soon as we begin to talk about feeding animals we have to use a number of terms which are not understood by every one. The various articles which are fed, such as hay, fodder, grain, meals, etc., are called *feeding stuffs*. These feeding stuffs are divided into two large classes; namely, *nitrogenous* and *non-nitrogenous* feeds. As the soil and the air contain a number of chemical elements which are necessary for the growth of the plant, so do these feeding stuffs contain many elements necessary for the animal body. Among these we may mention carbon, hydrogen, nitrogen, oxygen, sulphur,

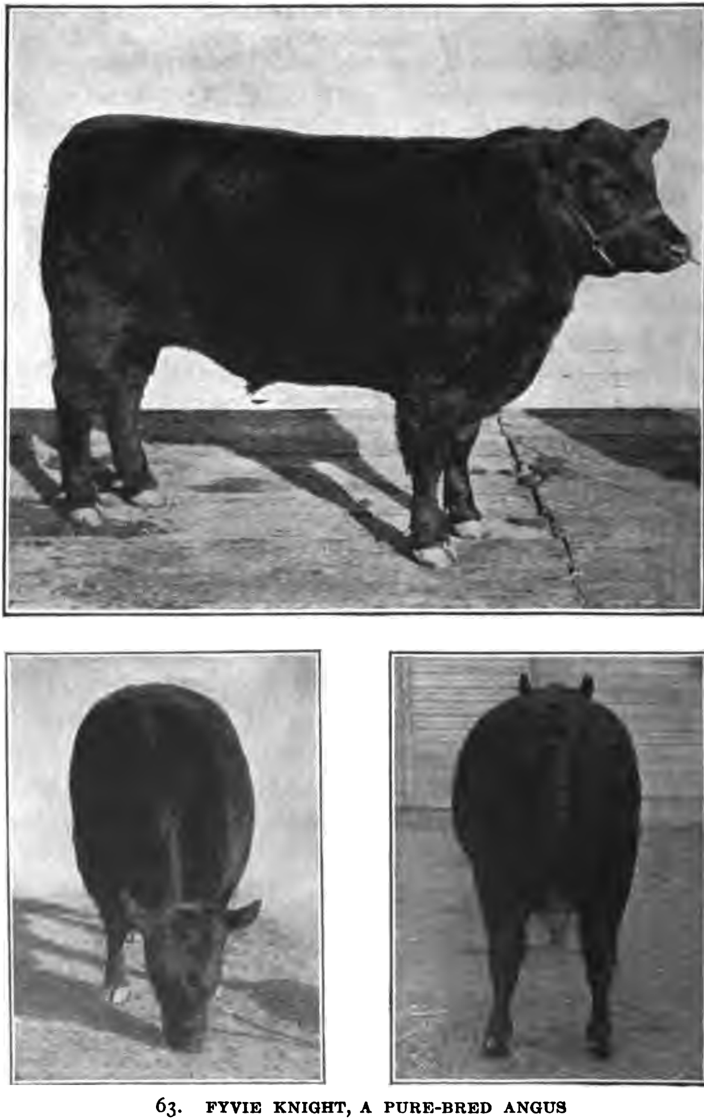
phosphorus, potassium, sodium, calcium, magnesium, iron, manganese, silicon, chlorine, and fluorine. The line on which feeds are divided into the two classes just mentioned is not well established.

Both of these classes contain all of the elements named above. However, we rarely speak singly of the carbon, hydrogen, oxygen, and nitrogen which foods contain, but of the compounds which they form. In speaking of the composition of a feeding stuff we usually mention six things; namely, water, ash, protein, crude fibre, nitrogen-free extract, and fat.

It is well known that all green plants contain much *water*. Water constitutes about eighty per cent. of the weight of green corn plants. Timothy hay has about fifteen per cent. and dry corn about ten per cent. of moisture. When this water is removed by heating in an oven at a temperature a little above boiling, the dry material left is referred to as *dry matter*.

The *ash* of the plants is what is left after they are burned. If we were to burn a hundred pounds of corn kernels there would be left about one and a half pounds of ashes. The other ninety-eight and one-half pounds would have passed into the air as gases. Of the elements mentioned above, all would be left in the ashes except the carbon, hydrogen, oxygen, nitrogen, and chlorine. The elements that are left in the ashes are called *mineral* matter. Different feeds contain different amounts of mineral matter. This mineral matter is very necessary for animals. Lime and phosphorus help to make bone; iron makes the blood red; chlorine and sodium help in digestion; and so the various other elements serve different purposes.

Protein is the name given to the different forms in which nitrogen is found in feeds. Protein is the substance which



63. FYVIE KNIGHT, A PURE-BRED ANGUS

Grand Champion fat steer at International Live Stock Show, Chicago, Dec., 1908

builds tissues; that is, cartilage, tendons, and lean meat or muscle. Besides this, it enters into the casein and albumen in milk and seems to be a stimulator of milk and egg production. When necessary the body uses protein to make fat and to furnish heat to keep the body warm and energy with which to move it, but when an animal is properly fed the protein is not much used for such purposes.

Crude Fibre is the tough, woody part of plants. It is composed mainly of cellulose and is not easily digested. Cellulose is the substance that makes the walls of cells and has the same composition as starch, but is not nearly as easily digested. Any food which is composed mainly of stems or has many hulls in it will contain a large percentage of crude fibre and will not be first-class feed. Grains have much less crude fibre than hay and fodder. For example, wheat contains about 1.8 per cent. and clover hay about 24.8 per cent. crude fibre.

All feeds contain some *oil* or *fat*. There is more fat in feeds derived from seeds like corn, oats, or cotton-seed than there is in hay. In the process of analysis the fat is dissolved out with ether, and for this reason fat is often referred to in tables of food composition as *ether extract*. Fat is composed of carbon, hydrogen, and oxygen, and serves the same purpose in the body as the nitrogen-free extract.

The *nitrogen-free extract* is what is left after the crude fibre, fat, protein, and ash have been removed. It, too, is composed of carbon, hydrogen, and oxygen. According as these elements are united we have starch, sugar, gum, and other substances. Nitrogen-free extract and crude fibre are often spoken of as *carbohydrates*. The carbohydrates and fats are the fuel of the body. By the process of digestion they are

changed just as wood or coal is changed in the fire and in the same way give heat. This heat furnishes warmth to the body and also energy for the action of the body. The carbohydrates and fat also form fat in the animal body, and from these comes the fat found in milk.

Nearly all feeds have a large per cent. of nitrogen-free extract, but the per cent. of fat or oil is small except in such feeds as gluten feed and cotton-seed meal, where the per cent. may be as much as ten or twelve. The per cent. of nitrogen-free extract is usually somewhere around forty in hays, while in seeds it is usually from sixty to seventy-five. A feed which contains a good deal of protein and fat always has a lower per cent. of nitrogen-free extract.

Besides the above terms *roughage* and *concentrates* are often used in speaking of feeds. Roughage refers to all kinds of coarse feed such as hay and fodder. Concentrates is applied to all grains and meals.

The *digestibility* of a food has reference to the amount which becomes available for the use of the animal through the action of the various digestive juices in the alimentary tract. It is only the digestible part of the food which the animal can use for making blood, muscle, bone, etc. The undigested part passes off as solid excrement. The digested part which is not stored up in the body is passed off mostly in the liquid excrements along with the wastes of the body.

The amount of a food which is digestible may be expressed in per cent., and this is called the *coefficient of digestibility*. For example, the average protein in shelled corn is about 10.3 per cent. and its digestibility is about 76 per cent. Then in 100 pounds of shelled corn there would be 10.3 pounds of protein, of which 76 per cent., or 7.828 pounds, is digestible.

The *palatability* of a food is important. By palatability we mean the taste of the food. If an animal eats its feed greedily, it is because it likes the feed, that is, the feed is palatable. Some feeds show a very desirable composition, but, because they do not taste good, animals will not eat enough of them to produce good results. Then, too, when a food tastes good the digestive juices in the mouth, stomach, and intestines are secreted in greater quantity to digest the food, and, consequently, a larger quantity of the food is digested and used by the animal.

In the table of *Digestible Nutrients* (see Appendix) it will be seen that the various kinds of feeding stuffs are grouped together. 1. *Green fodder* is a roughage fed green. The dry matter in green fodder is quite small. This is because green plants have a large per cent. of water in them. The amount of protein, carbohydrates, and fat in one hundred pounds of green fodder is small when compared with that in one hundred pounds of the dry fodders. 2. The *dry fodders* and hays are the green fodders cut and cured. The dry matter and food elements are large in this group. 3. The *straws* have a large amount of dry matter and crude fibre, but are very poor in protein and fat. 4. *Roots and tubers* have less dry matter and fewer food elements than any other group of feeds, except milk and its products. However, roots and tubers are valuable feeds, because of their good effect in keeping the digestive system of the animal in good condition. 5. *Grains and other seeds* are high in dry matter, protein, carbohydrates, and some of them in fat. They belong to the *concentrates*. 6. *Mill products* are nothing but the grains ground into meal. Their composition is not greatly different from the unground grain. The feeds given in the table up to

this point may be called *home-grown* feeds, since they can all be produced on the farm. 7. Under the heading of *waste products* there is given a long list of products which are left in the manufacture of certain commercial products. For this reason they are often called *by-products.* For example, the gluten meals and gluten feeds are the waste products in the manufacture of glucose from corn, and brewers' grains and distillery grains come from the large breweries where alcoholic liquors are made. It will be noticed that nearly all of these feeds are high in dry matter and quite rich in protein and fat. The waste products are the group of *commercial concentrates.* Nearly all are high-priced feeds owing very largely to their protein content. This group is often called the *supplementary* feeds, because they are used to fill out and balance the home-grown feeds. 8. *Milk and its products* may be considered a home-produced group. While the dry matter and food elements in the group are quite low, yet every farmer and feeder knows their great value for feeding to swine.

CHAPTER XXXVII

BALANCED RATIONS AND FEEDING STANDARDS

THE food which is fed to an animal daily is called its *ration.* The digestible elements in the food are called *nutrients.* When the different digestible nutrients are in the right proportions to meet the needs of the body under a given condition without excessive waste, the ration is said to be in balance, that is, it is a *balanced ration.* A balanced ration may consist of a single food, but it is usually a mixture of two or more.

It has been found that in a ration there does not need to be so much protein as carbohydrates and fat. The proportion of these nutrients varies according to the purpose of feeding. If milch cows are being fed, the proportion of protein to carbohydrates and fat is larger than if fattening steers are being fed. The proportion of digestible protein to digestible carbohydrates and fat is called the *nutritive ratio.* When the proportion of protein is large the nutritive ratio is said to be *narrow.* When it is small the ratio is *wide*; and when the proportion is medium the ratio is said to be *medium.*

To determine the nutritive ratio of a feed or a mixture we multiply the digestible fat by 2.25, because it has been found that fat will produce 2.25 times as much heat as carbohydrates, and add the product to the digestible carbohydrates. This sum is then divided by the digestible protein in the foods and the quotient placed as the second term in a ratio

with 1 as the first term. For example, oats (see Appendix) contain in every 100 pounds about 9.25 pounds of digestible protein, 48.3 pounds of digestible carbohydrates, and 4.18 pounds of digestible ether extract or fat. Now 4.18 times 2.25 equals 9.40; 9.40 plus 48.3 equals 57.70, and 57.70 divided by 9.2 equals 6.1 +. Therefore, the nutritive ratio of oats would be 1 : 6.2, which would be considered a medium ratio. According to Dr. Jordan, of the New York Experiment Station, a ratio less than 1 : 5.5 is a narrow ratio, above 1 : 8.0 a wide ratio, and anything between these two may be considered a medium ratio.

Many experiments have been made to determine how many pounds of digestible nutrients an animal should receive in its food each day, but the problem is largely unsolved. The amount needed is influenced by a great many conditions, some of the more important of which are the conditions and purpose of the animal, its age, and the conditions of temperature under which it is kept. In general a young, growing animal, or cow giving a heavy flow of milk, needs a ration having a rather narrow ratio, that is, a larger proportion of nitrogenous foods. A mature animal or one laying on fat requires a ration of medium or wide ratio.

Experimenters have attempted to arrange in tables the digestible nutrients necessary for animals of various ages and conditions. These tables are called *feeding standards*. However, practical men have not found these standards very useful, and they are not generally used except as guides to intelligent practice. The practical man must always study his animals and the feed which he has available and so adjust them as to get the largest returns possible in the most economical manner.

CHAPTER XXXVIII

SELECTING ANIMALS AND METHODS OF FEEDING

1. **Selecting Animals to Feed.**—There is a great difference in individual animals as to the increase in weight or gain which they will make when being prepared for market. Men who have fed large numbers of animals have learned from experience to pick out those which will feed profitably. There are certain indications, like the shape and character of the head, the conformation of the body, the back, the coat of hair, and the quality of the bone, which mark an animal as being a good feeder. The following quotations from Circular 14, Purdue University Agricultural Experiment Station, give the characteristics of a good steer for feeding purposes. Since the same principles in general apply to sheep and hogs, the descriptions may be made applicable to all:

A typical beef steer is blocky and compact, has a short, deep body, short, thick neck, short, straight legs, straight back and underline, an abundance of width from one end to the other, plenty of scale, or weight, and a 'feeder's head and eye.' The skilled feeder buyer pays more attention to the head than the inexperienced buyer would deem necessary, especially with stock cattle, which are not filled out sufficiently to judge as to their future development and probable form when finished. He will also realize at first glance whether or not the eye is one that indicates a quiet and contented disposition.

The head should be broad, short, with full forehead, strong jaw, large mouth and nostrils, and free from either coarseness or delicacy.

If such a head is found on a steer in feeder condition, it is usually a guarantee that he will make good use of feed and develop into a thick, blocky individual when finished. A thick, short neck is desirable, not because of its intrinsic value, but because it usually indicates a thick carcass.

A short, straight back indicates strong muscular development and a tendency to mature early. Other things being equal, the steer with the broadest and thickest back will be the most valuable, as the highest-priced cuts of meat are taken from the back and loin. For this reason,

64. A HIGH-GRADE STEER IN "FEEDER" CONDITION

He made a daily gain of 3.08 pounds for six months in a feeding experiment

By courtesy of the Indiana Experiment Station

feeders should be selected which will develop wide, thick backs in order that they may sell for top prices when fat. A desirable depth of body and spring of rib result not only in a greater proportion of high-priced meat but also give the steer the capacity for a large development of vital organs and ample room for a large digestive system without any tendency to paunchiness.

Capacity for feed is essential in a feeder, as the body must be maintained and provided with heat and energy before any of the food is stored in the form of fat. All that the steer can consume, digest, and assimilate above maintenance requirements is used for production; hence the

greater the capacity the greater the proportion of feed that is utilized for production and the less for maintenance.

Short, straight legs, together with a short, deep, broad body, are associated with early maturity. This is desirable from the producer's stand-point, as it enables him to market his cattle as feeders weighing 1,000 pounds at 18 to 20 months instead of keeping them a year longer in order to attain the same weight. The early maturing steer will also sell for a greater price per pound, as the experienced feeder has learned that they will not only make rapid and economical gains but will finish

65. A POOR TYPE OF STEER FOR FEEDING PURPOSES

This steer made a daily gain of .77 pounds for six months in a feeding experiment. Compare the form of this steer with that in Fig. 64

By courtesy of the Indiana Experiment Station

more quickly than those which are slower in maturing. Not only is this type more desirable to the producer and to the feeder, but also to the packer, as the early maturing kind yield a higher dressing percentage, thicker cuts, and greater proportion of high-priced meat.

In the stocker or feeder, quality is synonymous with capacity and early maturity. It is indicated by a thick, fine, bright, or oily coat of hair, a fine, hard, dense bone, and an appearance of refinement, smoothness, and symmetry throughout. Such a coat as described is generally associated with a healthy, pliable, and mellow skin; as the inner digestive organs are continuations and modifications of the outer skin, health in

one usually indicates health and activity in the other, insuring a good use of food and rapid gains. Smoothness and symmetry, together with quality and beef type, shorten the fattening period. As the gains in the feed lot are expensive, this is an important factor in favor of the steer which possesses quality.

Not only should a great deal of attention be given to quality in feeders because it insures less expense in finishing, but because it enhances the value of the finished or fat steer. Quality in fat steers when combined with beef type, means higher dressing percentage, even covering of fat on carcass, large proportion of high-priced cuts, better mixture of fat and lean, or marbling of meat, less waste in cutting, and finer muscular fibre, all of which make the steers with quality more valuable to the killer than those which are plain and coarse.

Besides the above conditions of type and quality it is essential that the animals chosen for feeding be well bred; the offspring of pure-bred sires is always to be desired. Such animals feed with more profit than low grades or scrubs.

2. **Methods of Feeding.**—(*a*) *Pasturing.*—Grass is nature's own food for our domestic animals. Pasturing or grazing is one of the cheapest methods of feeding. There is none of our farm animals which cannot be kept profitably during the warm season on good pasture. In some cases it seems advisable to feed a small quantity of grain in connection with the pasture. This is especially true for steers and pigs. It has been demonstrated that it usually does not pay to feed grain to milch cows when on good blue-grass pasture.

Besides the grasses other crops are pastured, such as clover, rape, cow-peas, soy-beans, and corn. Clover is good pasture for all animals and particularly so for young pigs. Rape is excellent pasture for pigs and sheep, but some grain should be fed in connection with it. Care should be taken not to turn animals into rape when it is wet with dew because it will cause the skin of pigs to chafe and will produce bloat in sheep.

Rape can be pastured by cows, but it may taint the milk and is also likely to produce bloat. Cow-peas and soy-beans are pastured to the best advantage with hogs. Standing corn can be pastured with sheep and hogs. The sheep will eat mainly the leaves, while the hogs will feed mostly on the ears. "Hogging off" corn is very frequently done in the corn-belt, and in dry autumns it is a satisfactory way of harvesting the corn crop. It is not advisable to pasture the same piece of ground at the same time with both sheep and hogs, because sheep do not like to feed where hogs have mussed over the stalks. It is also a common practice in the corn-belt, where not much corn is cut and put in shock or silo, to pasture the standing stalks, after the corn has been gathered, with all classes of farm animals, especially the young animals. This is a wasteful practice, because much of the feeding value has already been lost by the leaves blowing away. Furthermore, most of the soluble part has been washed out by rains. This practice frequently is false economy on account of the harmful effect of trampling the soil when wet.

(*b*) *Soiling.*—This is cutting the plants green and feeding them at once in the stalls or yards. This method of feeding requires a great deal of labor, but is economical in that a large number of animals can be kept on fewer acres. Pasturing always requires a large area of land, while soiling does not. Soiling is practised mostly by dairymen, but it should be used more than it is by all farmers who keep animals, especially in the warm, dry summer months when pastures are short and flies are bad. Some grain may be fed to advantage in connection with the green plants. The various crops used for soiling have been discussed under Soiling Crops.

(c) *Feeding Dry Feed.*—In the northern states all live stock has to be fed during the winter months. The farmer usually has only hay, straw, or stover for feed. The milch cows and work-horses usually receive some grain, but the other animals rarely receive any. This way of wintering animals is not the best, because the young animals need some grain to keep them growing. Then, too, all the animals keep in better health and make better use of their feed if some kind of succulent feed, like silage or root crops, is fed.

Animals which are being fattened are usually fed heavily on dry feed, largely grain. Silage is not generally used by stockmen for feeding fattening steers, as its profitableness has not been fully proved. The question whether it pays to house or shelter live stock has been much discussed, and various experiments have been conducted to find the correct answer. The results of experiments seem to indicate that fattening animals do better when fed in open yards and with a shelter closed on two or three sides under which to sleep and seek protection from bad weather. In the case of animals which are not fattening, such as milch cows and young growing animals, it has been shown that housing in a well-ventilated barn with open yards to go into on pleasant days is best. Fattening animals create a great deal of heat in the digesting of their food, and as fat is produced some is laid on under the skin which helps to keep the animal warm.

(d) *Grinding and Cooking Feeds.*—It is frequently asked whether it will pay to grind feed for animals, and whether cooking adds to its digestibility. These questions have been carefully studied by the various agricultural experiment stations as well as by practical feeders. It is generally agreed that grinding the grain fed adds to its digestibility. The di-

gestive juices have opportunity to act more completely upon ground grain than upon unground. Moreover, the animals waste less when feeding. However, the cost of grinding determines whether it will pay or not. When grinding costs more than one-tenth of the value of the grain, it is not likely to pay.

It may be briefly stated that cooking the food rarely pays. In many experiments animals have not done as well when fed cooked food as when fed raw food. Furthermore, the shredding of fodder and the cutting of hay do not usually pay.

(e) *Salt.*—All live stock should be given the opportunity to get all the salt they want. Salt is not a food nor does it increase the digestibility of feeds, but it stimulates the secretion of digestive juices, tones up the digestive system, and makes the food more palatable. When common salt is used for salting it should be given regularly every few days, so that the animals do not eat too much. It should not be placed directly on the food, but in a convenient place for the animals to take what they wish. Rock-salt is much used by stockmen. This kind of salt is in hard lumps, and the animals lick the rock until they are satisfied.

(f) *Pigs Following Cattle.*—Cattle fed on grain do not fully digest all of it, and much of it passes through the animal and appears in the excrement. Every feeder knows the desirability of having pigs follow the cattle to pick up all such grain. In the case of fattening steers fed on corn, there will be enough grain in the droppings to keep in good growing condition one pig per steer. Feeders generally prefer a pig weighing about a hundred pounds. It often happens that the only profit made in fattening steers is in the gains made by the pigs following them, and the returns from increased yields due to the manure produced.

SECTION V—DAIRYING

CHAPTER XXXIX

DAIRYING

THE human race has used milk and its products since the earliest times. The oldest writings speak of milk, butter, and cheese. There is scarcely a man, woman, or child in the civilized population of the world who does not use every day in some form the product of the dairy. The importance of an industry which concerns so many cannot be easily stated in words.

It will be well to understand before going further what a dairy is. We are apt to think of a dairy as being a place where a large number of cows are kept and their milk prepared for use either as butter or for drinking. Such a place is truly a dairy, but the farmer who has no more than one cow and uses her milk for butter or for drinking also has a dairy. The only difference in the two dairies is the extent of the operations.

Dairying, then, is the keeping of one or more cows and using the milk for drinking, butter, cheese, or some other milk product. Of course, we do not say that the farmer who raises hundreds of bushels of grain and keeps only one or two cows is a dairyman, but so far as he keeps cows and makes use of their milk he is engaged in dairying. He does not make

dairying any large part of his business. If, on the other hand, a farmer does not use the milk for human use, but feeds it to calves or pigs, he is not engaged in dairying, but in the raising of live stock to that extent.

All dairies are not located on farms. There are many dairies in large cities where the cows are kept in stables all

66. THIS IS A TYPE OF THE MODERN DAIRY BARN, FITTED FOR THE PRODUCTION OF CLEAN MILK

Notice the possibilities for sunlight and ventilation. The cement floors aid in cleanliness

By courtesy of the Indiana Experiment Station

the time and fed all their feed in the manger. Such dairies are engaged in supplying milk to the city population. However, most of the milk is produced on the farm and a large part of the butter is made there also, although much of the butter sold in cities is made from milk brought to factories called *creameries*.

In dairying the most important item is *cleanliness.* There is probably no article of food more difficult to keep clean and fit for food than milk. Every one means to be particular about what he eats, but the dirt which he eats in milk and butter would astonish him if he were to see it sep-

67. A PROFITABLE HERD OF DAIRY COWS
This herd made an average yearly record of 259.6 pounds of butter-fat per cow
By courtesy of the Indiana Experiment Station

arated from the milk. To produce milk and butter of high quality and to succeed in a high degree, several things are essential.

1. *Necessary Equipment.*—The equipment necessary is not large, but it should be suitable and of good quality. The vessels in which milk is to stand should be glazed earthenware or heavy tin plate. The buckets into which the milk is drawn from the cow should be heavy tin and thoroughly

clean. All joints and seams in the vessels should be soldered over so that they can be easily cleaned.

A cool place for keeping milk is necessary. This may be a refrigerator, a cool cellar, or a trough in a shaded place with cold water running through the trough. Unless milk is quickly cooled after being taken from the udder and kept cool it will soon become sour and unfit to use. A well-ventilated ice-box is perhaps the best place for keeping milk, for in the ice-box the temperature can be controlled. Ice is a necessity in running a large dairy properly, and it is very convenient where only a small amount of milk and butter is handled.

2. *Adaptable Breeds of Cattle.*—Of course milk, butter, and cheese may be produced from any of the breeds of cattle, but all breeds are not profitable for dairy purposes. The beef breeds do not produce enough milk to make them profitable. If one is engaged in producing milk, he should keep only such cows as give large returns for the feed which they eat. If the milk is made into butter, only such cows should be kept as give milk rich in butter-fat. Pure-bred or very high grade dairy breeds are usually to be preferred to scrub breeds.

3. *Industry.*—There is probably no branch of farm work which requires more industrious attention than dairying. Cleanliness is always uppermost in the dairy business, and this requires work. Cows must be milked regularly at the same hour every day, and best results are obtained if the same person milks the same cow every time. This means that one must be every day at his work.

CHAPTER XL

COMPOSITION AND QUALITIES OF MILK

MILK is a white liquid with a yellowish tinge. It is secreted from the blood by two large glands. These glands lie outside the body walls, being covered by the skin, and form the *udder*. Each gland has two sections or quarters. From each section there is a tube or duct through which the milk is drawn. This duct is enclosed by fleshy walls and is called the *teat*. At the top of each teat there is a small cavity capable of holding from one-half pint to a pint of milk. This cavity is called the milk cistern. Leading into this cistern are ducts from other parts of the gland. These ducts have their origin in small clusters of cells where the milk is secreted. There is a network of blood vessels extending throughout every part of the gland. The glands on the right and left sides of the udder have no connection whatever, and there is very little connection between the front and hind quarters of either half.

The udder contains very little milk at any one time. Most of the milk is secreted while the milking is being done. Just how this secretion takes place is not well understood, but we know that milk is a true secretion, because the elements which it contains are different from the elements found in the blood. The milk is kept from leaking out of the udder by a little muscle which draws the opening at the end of the teat tight shut. This muscle is called a *sphincter* muscle. Occasionally

this muscle is weak and does not close the opening tightly; then the milk leaks out. Sometimes it is very strong and does not let the milk out easily; the cow is then "hard" to milk. The cow has some control over the sphincter muscles which guard the openings from the milk cisterns and can "hold up" her milk. She does so usually only when scared or angry. A feed at the time of milking will cause her to forget her excitement. Excitement also hinders the secretion of milk in the glands. Kindness and quietness should always be observed in handling milch cows.

Milk contains all the food elements necessary for the growth and development of young animals. In America the milk from the cow is the only milk that is used for human food, but in some countries the milk from the ass, mare, goat and ewe are also used. Cow's milk does not have a fixed composition. There are several things that affect it. Of these we shall speak in another paragraph. The component parts of milk may be grouped as follows: 1. Water. 2. Albuminoids, namely, casein and albumen. 3. Fats. 4. Sugar. 5. Ash. The last four items are called *milk solids*. They may be arranged in outline as follows:

- Milk
  - Water............87.5%
  - Solids............12.5%
    - Ash............... .7%
    - Sugar.............4.7%
    - Albumen........... .5%
    - Casein............2.8%
    - Fat...............3.8%

The specific gravity of cow's milk is usually taken at 1.032.

A study of the composition of the milk from the several kinds of animals shows that they vary a great deal, but all

contain the same elements The specific gravity also is rather variable. The fat in milk has a tendency to make it lighter, while the casein, sugar, and ash tend to make it heavier.

The fluid part of the milk in which the fat globules float is called *milk serum.* In the serum the milk solids are found in two conditions. The fat and some of the casein are in suspension, the rest of the solids are dissolved.

The fat in cow's milk is the ingredient which varies most. The other solids are fairly constant. Although the average for thousands of samples is given as about 3.8 per cent., the range of percentages of fat is from 2 to 10 per cent. Very few cows give milk containing more than 7 per cent. of fat, while many give milk having 3 per cent. and less.

There are several things affecting the per cent. of butter-fat. Briefly, they are as follows: 1. The individual cow. Some cows naturally give milk richer in milk-fat than others, although they may be of the same breed and receive exactly the same care. 2. The breed. At the New York (Geneva) Experiment Station it was shown that the milk of Jerseys was richer in percentage of fat than that from any other breed. However, the breed of a cow is not a sure sign of the richness of her milk. More depends upon the cow herself. 3. Period of lactation. A cow gives her largest flow of milk after the calf is a few weeks old, but the per cent. of fat is larger usually after she has been giving milk for some time and the quantity begins to decrease. 4. Comfort. The comfortable cow will usually give richer milk than one that is uncomfortable. 5. The first milk drawn is poorer in fat than the last drawn or "strippings."

The feed which a cow eats does not affect the per cent. of fat very much. Many experiments have been conducted to

find out if it is possible to increase the per cent. of fat in a cow's milk, but they have all failed to do so. The food does influence the quality of the fat, but not the quantity, except as it influences the amount of milk given by the cow. Cottonseed meal makes the fat globules hard, while oil meal makes them soft.

As was observed in the table, the specific gravity of milk is greater than that of water; that is, milk is heavier than water. The space which would hold 1,000 pounds of water would hold 1,032 pounds of milk. The sugar in milk gives it a sweet taste. Milk has an odor due to certain volatile oils in it. The yellowish tinge is given to it by the globules of fat. The milk from a fresh cow or one feeding on succulent feed has a more yellowish tinge than the milk from a cow old in milk or one fed on dry feed. Milk from Holstein cows is whiter than that from Jerseys. If fresh milk be tested with red litmus paper it will turn the litmus paper blue, showing an alkaline reaction; but if blue litmus be used it will be turned red, showing the presence of an acid. The acid condition is said to come from the casein, while the alkaline condition is the natural state of the rest of the milk. However, if milk stands for a short time, it becomes definitely acid.

Colostrum.—The milk which a cow gives while a calf is very young is quite different from ordinary milk and is called *colostrum*. It is especially adapted to the needs of the young calf, but is not at all fit for human food. The colostrum is a sticky, yellow, sweet milk, quite rich in albumen, and has less water than ordinary milk. Milk should not be used for human food until the calf is four days to a week old. It is safe to use fresh milk that does not coagulate when boiled. A purple precipitation in a test-tube after adding a little sul-

phuric acid is also a sign of colostrum. Physicians in cities say that many children die every year owing to the colostrum in milk furnished by dairymen.

Abnormal Milk.—Salty milk is sometimes obtained from cows. Its cause is not clearly known, but as a cure the cow should be *dried off*, that is, be allowed to stop giving milk. *Bloody milk* may be due to an injured condition of the udder, or it may be due to certain bacteria which develop after the milk has been drawn. Blue milk, yellow milk, ropy milk, and bitter milk are all due to certain germs which may get into milk after it is drawn and cause these various conditions. Bitter milk is sometimes also caused by food which the cow has eaten. Milk from a sick cow, or one in any way not in perfect health, should never be used for human food.

CHAPTER XLI

PRODUCING GOOD MILK

To produce milk which is absolutely pure and fit to use for drinking, or for butter or cheese, requires more care than any other work on the farm. Careful attention must be given to the vessels in which milk is handled, the surroundings of the cows, the place where milk is kept, and the actual process of milking. The dairyman or farmer must realize the importance of keeping everything clean.

1. It is necessary to know that milk is easily made unfit for use by dirt. The dirt which gets into milk carries with it many small, one-celled bodies, called *bacteria*. These are a form of plant life. With the proper temperature these bacteria grow very rapidly. A single bacterium may increase so rapidly that in a period of twenty-four hours its offspring and their offspring may number many millions—all so small that they are not noticed. However, their presence in the milk causes it to become sour, and acids are formed which may be injurious if taken into the stomach. Disease-producing germs, or bacteria, are often introduced through the dirt which gets into milk. Scarlet fever, tuberculosis, diphtheria, measles, and many other diseases may be carried and spread in this way.

2. As was stated in Chapter XXXIX, the milk pails should be made from the best quality of tin, with all joints and

seams soldered over so they can be easily cleansed. All other vessels should also be constructed in the same way. All vessels in which milk is handled should be thoroughly washed, scalded, or steamed, and exposed to the sunshine after being used. Before being washed with hot water, milk vessels should be rinsed with cold water. The hot water melts the fat and cooks the albumen and makes it more difficult to cleanse the vessel. A little washing powder or soap added to the water is desirable. After the washing has been done a thorough rinsing with scalding hot water, or a good steaming, should be given. Exposure to sunshine is necessary, because sunshine is death to bacteria and is also a great sweetener and purifier. Milk is one of the best places for bacteria to grow, and when pails and cans are carelessly washed, or milk is allowed to dry in the seams and joints, bacteria multiply very rapidly.

3. Milch cows should be kept in clean and healthful surroundings. The stables and yards should be clean and dry. Cows kept in dirty and foul-smelling stables cannot give milk of the best quality, nor can the milk gathered under such conditions be entirely pure. Milk takes up odors very readily. Hence it is impossible to draw milk in a foul-smelling stable without tainting it. The yards into which cows are turned in the winter and spring should be as dry as possible. It is not good for the cows to wade in mud and manure, and some of the mud and filth which will get on the cow are sure to get into the milk at milking time.

It is important that the stables in which cows are kept should be well ventilated. There should be space enough in the stable to give each cow about 500 cubic feet of air to breathe. There should be windows to let in the sunlight, for

sunshine is a good disinfectant. The walls and floors should be tight so as to avoid drafts of air. Ceilings should be seven or eight feet high with a tight floor. In dairy districts tuberculosis is very common among dairy cows, and it is partly due to the housing of cows in ill-ventilated, dark, and dirty

68. UNFAVORABLE CONDITIONS FOR THE PRODUCTION OF CLEAN AND HEALTHFUL MILK

During the cold months many milch cows are stabled in barns no better than this one

By courtesy of the Indiana Experiment Station

stables. It is a good practice to groom the milch cow every day. Grooming not only keeps the skin clean, but also keeps it in a healthier condition. The manure which may get on the hind legs from lying down in the stall should be cleaned off every day, otherwise it collects in chunks, is unsightly, and some of it is sure to get into the milk.

4. Much dirt gets into the milk at milking time. When the

cow has been lying down in her stall or in the field, more or less dirt and dust cling to her udder and the under part of her body. If this is not brushed off, it is sure to get into the pail when the milk is drawn. There is also always a great deal of scurf which rubs from the skin and drops into the milk pail. Therefore, before the milk is drawn the udder and the surrounding parts should first be carefully brushed with a good bristle brush like that used for brushing horses. Then a moist sponge should be used to dampen the hair and skin. Sometimes it may be necessary to wash the parts well, but it is better to brush them off well unless they are very dirty.

69. AN UNKEMPT DAIRY COW

Clean milk cannot be produced from cows kept in this condition

By courtesy of the Illinois Experiment Station

The milker should wash and dry his hands before beginning to milk and should keep them dry while milking. He should also brush his clothing well before beginning to milk. In many dairies the milkers put on clean white suits and caps before beginning to milk. The milking should be done quickly, so that as little as possible of outside dust can get into the milk. It is sometimes necessary to have a cloth over the

top of the milk pail in summer when milking, so that no flies can get into the milk. The fly has many bacteria on its legs and feet, and these will be washed off into the milk, making it unclean. We need to realize more than we do that flies

70. WASHING THE UDDER BEFORE BEGINNING TO MILK
By courtesy of the Illinois Experiment Station

are dangerous to health by reason of the dirt and disease which they carry.

5. As soon as the milk is drawn it should be removed to another place, strained, and cooled at once. The place where the straining is done should be perfectly clean, free from odors, dust, flies, dogs, and cats. A fine wire strainer with eighty meshes to the inch should be used for straining the milk.

Creaming.—By creaming we mean the separating of the butter-fat from the milk. Milk as it comes from the cow is

called *whole* milk. After the fat has been removed it is called *skim*-milk. It is not easy to separate the fat alone, so that some milk is also taken with the fat, and this is called *cream.* Cream is milk with a very large per cent. of fat in it. When

71. A MILKING MACHINE AT WORK

Many large dairies are using these machines. They lessen the labor of milking and keep the milk clean. The machine is operated by compressed air

milk is allowed to stand in a vessel for some time the globules of fat gather at the surface and form the cream. A low temperature is favorable to the rise of the fat globules.

There are four methods or systems of separating the fat or cream from milk; namely, by the use of shallow pans, by

deep setting, by dilution separators, and by centrifugal separators.

1. In the shallow-pan system the milk is put into shallow pans or crocks and set in a cool place, usually the cellar, for twenty-four to thirty-six hours. The milk is from two to eight inches deep in the pan or crock, depending upon the vessel. The temperature of the room ought to be about 60° F. At the end of the time mentioned the cream is removed with

72. THIS CUT SHOWS THE EFFECTIVENESS OF EACH OF THE FOUR METHODS OF SEPARATING THE CREAM

Note the small loss where the centrifugal separator is used: shown by the print at the left. *By courtesy of the Indiana Experiment Station*

a *skimmer*. This is usually a slightly concave tin disk with a handle. One cannot get all the butter-fat by this system. The temperature is usually not low enough to induce all the fat to rise to the top. About one-fifth of the fat is lost by this system. The skim-milk from this system nearly always contains .5 of 1 per cent. or more of fat.

2. In the deep-setting system the milk is put into cans about twenty inches deep and less than one foot in diameter and placed in cold water. The water used is cooled by ice so that it will bring the milk down to a temperature of 40° F. very quickly. It should be kept at this temperature for

twenty-four hours, when nearly all of the fat will have risen to the top. This method is quite effective and the amount of fat left in the skim-milk is often not more than .2 of 1 per cent.

3. A dilution separator is a can into which the milk is poured and then diluted with water, usually one-half. The can is made with a faucet so that the skim-milk can be removed from the bottom. The can is kept in a cool place or in cold water. When the milk is diluted the fat rises to the top more quickly. There are several objections to the dilution system: (a) The water used always has some germs in it. However, they may not always be injurious. (b) The cream obtained is not of the best quality. (c) The diluted skim-milk is not so good to feed to pigs or calves. (d) The fat is not all removed, as much as .7 of 1 per cent. or more may be left in the skim-milk. All experiment stations condemn the dilution separator.

4. The centrifugal separator is a machine. The milk runs into a bowl which is revolved several thousand times per minute. The revolving has a tendency to throw the heaviest particles to the outside of the bowl. Since the fat is not so heavy as the other parts of the milk, it would, therefore, be crowded toward the centre of the bowl. The cover of the bowl is so constructed that the cream, or fat, can escape from the centre of the cover, while the skim-milk escapes from openings nearer the edge of the bowl. There are many different kinds of separators and each has a differently constructed bowl. Most bowls have inside parts intended to spread the milk out in thin layers so that the centrifugal force can act more completely. There are some bowls which have no inside parts. They are known as *hollow* bowls. The separator does not separate the fat entirely by itself, but also

takes some of the other parts of the milk with the fat. The separator takes the fat from the milk more completely than is done by any other system of creaming. A well-operated separator rarely leaves as much as .1 of 1 per cent. of fat in the skim-milk.

73. A GOOD KIND OF MILK COOLER AND AERATOR

The milk is poured into the top and runs out of small holes, spreading over the surface of the lower part in which is ice-water

When milk is creamed with a separator it is done by running it through the separator as soon as it is drawn from the cow. Milk can be creamed after it has cooled, but it must be warmed again to at least 95° F. and be thoroughly stirred up before running it into the bowl. There are many things to be learned about operating the separator, if perfect work is to be done. However, the companies selling the machines usually give full directions for operating them. The two most important items are to have the machine set level, and to clean the bowl and its parts thoroughly after each time of using.

Milk for City Delivery.—Many dairymen and farmers sell their milk direct to customers in the city. All that has been said about cleanliness applies to milk being prepared

for city customers. Milk intended for city customers is not creamed, at least only a small part of it. The most important item in preparing milk for city delivery after cleanliness is the cooling of the milk. This is often neglected. Cooling is necessary in order to have the milk keep sweet a reasonable time after being delivered to patrons.

74. WHERE MUCH MILK IS BOTTLED FOR CITY DELIVERY, A MACHINE WHICH WILL FILL SEVERAL BOTTLES AT ONE OPERATION IS DESIRABLE

This one fills four quart and five pint bottles at one time

There are several devices for cooling milk. In all of them it is arranged to let the milk spread itself over a considerable surface in a thin sheet. This surface is kept cool by cold water underneath. After running over the surface the milk flows again into a can. By this method of cooling the temperature should be reduced to at least 60° F. Now, if it is delivered promptly and then set in a refrigerator by the housekeeper, the milk should be sweet and wholesome for at least two days, where, if it were not cooled, it would not keep longer than twenty-four hours. The cooling of the milk by spreading over a surface also *aerates* the milk, that is, exposes it to the air so that all odors escape. If the air of the milk-

room is perfectly pure this aeration improves the quality of the milk very much.

Milk which is delivered to city patrons should be bottled because it is cleaner. When each customer's amount is dipped from a can at each stopping place dust is sure to be introduced from the street. Also, the dippers and the vessel into which the milk is put are apt to have dust collected on them. Winds blowing the dust about city streets spread thousands of germs of all kinds. No kind of food should be exposed to this dust, and least of all milk. Keeping the bottles thoroughly clean is another important item in connection with city milk supply. They should be thoroughly scalded, steamed, and exposed to the sun.

CHAPTER XLII

BUTTER-MAKING

Butter is a product of milk that has been known from the earliest times. The early methods of making butter were very crude and consisted mainly in agitating whole milk in bags of skin until the fat globules gathered into clusters. The handling of cream and the process of making butter have received much study, and many improvements have been made.

Preparing the Cream.—On the average farm not enough cream is skimmed at one time to make a churning. It is necessary, then, to collect the cream from several skimmings or separations. If cream is separated with the separator it should be cooled at once to 40° F. or 50° F., and kept at that temperature until enough is collected for a churning. If cream is skimmed from pans, crocks, or cans it will not need to be cooled so much. The cooling is properly done by setting the cream in a can in ice-water and then stirring the cream slowly until it has reached the desired temperature. A dairy thermometer is a necessary article.

It is common practice on most farms to mix the cream from each skimming with that of the previous skimming, but this is not best if one wishes to make a high quality of butter. The older cream is sure to become slightly sour, and when cream of different ages is churned together the churning will

not be complete and much fat will be lost in the buttermilk. The butter will also be lacking in flavor. The cream, then, from different skimmings, if possible, should be kept separate and cool until enough is gathered for a churning. Then all should be mixed together, thoroughly stirred, and allowed to ripen.

By *ripening* we mean the souring of the cream. Butter can be churned from cream which is perfectly sweet, and this is often done. Such butter is called *sweet-cream* butter. It is a delicate product and will not keep long. Most of the butter sold on the market has been made from sour cream and it is known as *sour-cream* butter. The term *ripening* is usually taken to include all the changes that take place from the time the cream is skimmed until it is ready to put into the churn.

There are reasons for souring the cream before churning it. 1. The churning is more completely done. By the process of ripening, the cream is made less viscous and the fat globules can move through it more easily. In churning, then, the fat globules are collected together more easily and completely and very little fat is left in the buttermilk. 2. The butter keeps better. It has just been said that sweet-cream butter does not keep well, but soon loses its good quality. Butter made from sour cream keeps its good quality for some time if properly cared for. 3. The flavor and aroma are increased. When cream has been properly ripened it has a pleasant odor and flavor. These are developed by the souring process.

Cream is made sour by the action of bacteria. There are many species of bacteria which can make cream sour, but only a few of these develop the kind of sourness which gives the

desirable flavor and odor to the butter. These are known as the *lactic acid bacteria* or *ferments,* for souring is a process of fermentation.

There are two methods of souring cream; namely, *natural* and *artificial.* The natural method is the one commonly in use on the farm. It consists in letting the cream stand in a large jar or can at a suitable temperature, usually 60° to 70° F., until sour. The cream has a good many kinds of bacteria in it even when care has been taken to keep it clean. The lactic acid ferments are always present, and under favorable conditions they will develop and give to the cream that kind of sourness or acidity which will make butter of good flavor. But it often happens that conditions are not favorable for them, and this is especially true in the winter and early spring. This largely accounts for the poor quality of country butter at that time of the year. During the winter season milk and cream are often kept in the kitchen or pantry. In winter there is a lack of succulent feed and the period of lactation is usually far advanced. Under such conditions it is not easy to make butter of good quality.

Cream may be ripened artificially in two ways: (1) By adding to the raw cream a starter; (2) by adding a starter to pasteurized cream. A *starter* is a specially prepared lot of whole milk, skim-milk, or buttermilk that contains the desired lactic-acid bacteria. A whole-milk starter is made by taking a quart of milk just as it comes from the cow (care being taken to have it absolutely clean), putting it in a quart fruit-jar, and letting it stand on a shelf at a temperature of 70° F. for twenty-four hours. A skim-milk starter is made in the same way, but fresh skim-milk from the separator is used instead of the whole milk. A buttermilk starter is made by taking some of

the buttermilk from a churning in which the butter has been of excellent flavor. A skim-milk starter is usually preferred, because it will contain the desirable bacteria in a larger proportion than either of the others.

Another kind of starter is called *commercial starter*. It consists of a preparation containing the desired kind of bacteria. The preparation is made in special laboratories where everything is favorable to producing the right kind of bacteria. In *liquid* starters the bacteria are put up in sterilized bouillon, or milk. In *powder* starters the bacteria are contained in a powder of milk-sugar. Both kinds are good while fresh, but the liquid starter deteriorates more quickly than the powder. Commercial starters are used mostly in creameries, and full directions for use come with each package.

Cream and milk are *pasteurized* by heating to a temperature between 140° F. and 212° F., usually 160° F., for five minutes. Or temperatures of 155° F. for ten minutes or 150° F. for fifteen minutes or 140° F. for thirty minutes may be used. These temperatures kill practically all the germs commonly found in milk or cream. Having killed the germs of all kinds, the butter-maker can introduce by means of the starter just the kind of germs desired. Some of the advantages claimed for pasteurization are: (1) A more uniform quality of butter can be made; (2) many of the bad taints in the milk or cream are removed; (3) most of the germs are destroyed, and therefore the danger from disease germs, like scarlet fever, typhoid fever, etc., is lessened; (4) the keeping quality of the butter so made is increased. Pasteurization cannot be properly done without expensive machinery, and it is little used except by creameries and large milk plants.

On the farm, cream is usually ripened by the natural method. In the summer it should be kept in cool water until enough is collected for churning. Then it should be thoroughly mixed and set out of the water in the morning and allowed to ripen during the day. It can be set back in cold water in the evening and will be ready for churning in the morning. In winter the cream can be warmed up and allowed to ripen and then cooled. The best temperature for ripening is 65° to 70° F. The cream should be cooled to about 50° F. again and kept at that temperature for several hours before churning. In the winter one may wish to use a starter to help along the souring process. About one-tenth as much starter as cream is about the right quantity to use, but this depends upon the richness of the cream; a poor cream should have less starter. Cream is considered ripe when it has a thick, glossy appearance and smells and tastes pleasantly sour. The sourness is sometimes tested by an acid indicator. It should then show an acidity of .5 to .6 per cent. Care should be taken that cream does not become overripe, as overripe cream makes butter that soon becomes rancid. Care should be taken that the cream does not become too sour or the casein will be curdled and will appear as cheesy granules in the butter. Your Experiment Station will be glad to tell you how to make this test.

Churning.—After the cream has been properly ripened and cooled to the right temperature for at least two hours, it is ready to churn. *Churning* is the collecting of the fat globules into a mass. It is accomplished by agitating the cream in a vessel called a *churn*. In the process of churning the cream is whipped about from side to side or end to end of the churn, and the fat globules striking against each other stick together

in gradually increasing clusters, until they become visible to the naked eye as pale, whitish granules. As the churning proceeds the cream gets so thick that it will scarcely move in the churn, but finally the cream "breaks" and the small clusters appear as distinct, yellow grains, and if the churning be continued they gather into a large yellow lump of butter. It is best to stop the churning when the yellow granules are about as large as wheat kernels. The liquid which separates out from the butter granules is *buttermilk*. It should be drained off as soon as the butter "comes."

If butter color is used it should be put into the cream at the beginning of the churning. The amount to be used varies. Directions for use are usually on the bottle. More color is needed in winter than in summer.

A word should be said about churns. There are many kinds of churns. That kind of churn is best which has no inside parts. Inside dashers or paddles injure the butter granules and make the butter more or less greasy. Barrel, box, or swing churns are the best. The churn should always be made of wood, because the butter sticks to metal and is not easily removed.

Something should be said also about preparing the churn for churning. No matter how well it was washed at the last churning it should be again thoroughly scalded with boiling water. Throw in a gallon or two of hot water, move the churn two or three times, and quickly draw off the water. Then just as quickly as possible throw in a gallon or two of ice-cold water and give the churn several turns. The hot water should not stand in the churn, for the heat will penetrate the wood, making it warm, and this will warm up the cream. The purpose is to scald the churn and then cool it

as quickly as possible. It may be necessary to add ice-water, or cold water, a couple of times, especially in summer.

The cream when put into the churn should have a temperature of about 54° F. It will usually rise a couple of degrees in the churn, making the temperature 56° F. This is a desirable temperature in summer. A temperature of 60° F. is often better in winter, especially if the cows are fed all dry feed, with no silage or roots. Furthermore, a higher temperature is necessary if cows are old in their period of lactation. At the beginning of the churning it is necessary to ventilate the churn at each turn or two, if it be tightly closed, in order to allow the gases and expanded air to escape.

Washing the Butter.—As soon as the churning is finished the buttermilk is drawn or poured off. A fine horse-hair sieve should be used to catch the small particles of butter which may run off with the buttermilk. After drawing off the buttermilk enough water should be put into the churn to float the butter nicely. The churn should be shaken gently in order to bring all the granules in contact with the water. After standing ten or fifteen minutes, this water should be drawn off and another lot put in and the washing repeated. This lot should be drawn off completely and should come away rather clear. If it is not clear, repeat the washing. The object in washing is to remove all the buttermilk. When the buttermilk is left in the butter it spoils its flavor and its keeping quality. The wash water used should be the purest obtainable and should have a temperature about the same as the churning temperature. If the cream has been churned too warm and the butter comes soft, the water should stand on the butter for some time until it hardens, perhaps an hour. Water too cold will make the butter lacking in flavor.

Working the Butter.—Butter is *worked* by removing it from the churn and pressing it with a lever or paddle. The purpose is to remove surplus water, to mix salt with the butter, and to compact the granules together so that the butter can be put into packages for market or use. Butter can be worked best on a lever-worker. (See Fig. 76.) A wooden bowl and paddle are often used. It should always be pressed with the lever or paddle. A sliding motion destroys the granular structure and makes the butter salvy. A temperature of from 45° F. to 55° F. is best. In summer it is not easy to have this temperature. In creameries the churning is done by mechanical power and the butter is worked without taking it out of the churn.

75 A LEVER BUTTER-WORKER

By courtesy of the Wisconsin College of Agriculture

The amount of salt added to the butter at the time of working varies, but is usually three-fourths of an ounce to an ounce per pound of butter. (A good platform dairy scales is a necessary article.) The main reason for adding salt to butter is to improve its flavor. Most people prefer some

salt in their butter. The salt used should be uniformly fine in grain and dry, and should be scattered evenly over the butter and worked in with the worker. It should all dissolve completely. Sometimes butter is salted by using the salt as a brine.

Preparing for Market.—Country butter is usually put on the market in pound prints, being moulded out with a wooden mould which puts just a pound in a package. Butter is also made into large rolls or packed into crocks or wooden tubs, depending upon the quantity. The pound package is the most desirable form, but whatever the form is it should be neat and attractive. If the package is wrapped neatly in a sheet of parchment paper on which is printed the name of the maker or his farm, it will help the sale of the butter. Creamery butter is usually placed in butter tubs and later made up into pound packages.

Composition of Butter.—The composition of butter is not always the same, but on the average is about as follows:

Fat	83%
Casein, sugar, and ash	1%
Salt	2.5%
Water	13.5%

It is unlawful for butter to contain as much as 16 per cent. or more of water. The quality of butter is determined by its flavor, texture, color, salt, and the package. Your Experiment Station will be glad to send you sample score cards and explain how to score butter.

In the successful handling of milk, making of butter, and managing a dairy business, a very great deal must be learned by experience. One who studies carefully the principles which underlie the work and then applies them in a practical way is sure to succeed.

CHAPTER XLIII

MILK PRODUCTS, OTHER THAN BUTTER

BESIDES butter, the most important products made from milk are cheese, condensed milk, and ice-cream. The making of these products is the work of experts. In this chapter we cannot take the space to give much of the details concerning their manufacture.

Cheese.—Cheese is a milk product containing a large proportion of the milk solids. All of the casein, nearly all of the fat, and about two-thirds of the ash in milk are to be found in cheese. The albumen and milk-sugar in milk are entirely lost in cheese-making. In the process of manufacture the most important item is the coagulating of the casein. In ordinary milk the casein is partly dissolved and partly in suspension. Being an albuminous compound, it is easily coagulated either by heat or by acids. In cheese-making an acid is not used, but a ferment, which has a similar effect, called *rennet*. *Rennet* is obtained from the lining of a calf's stomach. In the making of *cottage cheese* on the farm heat is almost always used to produce coagulation, but considerable lactic acid is also necessary before coagulation will take place.

Cottage Cheese is almost always a home-made article. Sour skimmed milk is set on the stove and gently heated to from 85° to 125° F. for an hour or more. The coagulated part or curd then appears separated from the watery part or whey. The

whey is separated from the curd by pouring off and by straining through a cloth. Usually the mass is hung up in the strainer for a couple of hours and allowed to drain. After draining the curd is broken up by crushing in the hand. The curd is now salted to suit the taste and is ready for use. Usually before serving, a small amount of cream, butter, or rich milk is mixed with it. Some persons like spices mixed with it also. Cottage cheese is usually served fresh. Cottage cheese is also known as Dutch cheese, pot cheese, and schmierkase.

Cheddar Cheese.—While most of the cheese in America is made in regular cheese factories, in sections where dairying is the principal industry cheese is often made on the farm. The most common kind is that known as *cheddar* cheese or some modified form of it. The name cheddar comes from a town in England where the cheese was first made centuries ago.

The process of making cheddar cheese, according to one of the best authorities,* is briefly as follows:

1. *Setting.*—The whole milk is warmed to a temperature of 82° F. and ripened to the right degree of acidity, which is determined by an acid test. Rennet is then added at the rate of two or three fluid ounces per one thousand pounds of milk, and thoroughly mixed with the milk. The rennet coagulates the milk in ten to fifteen minutes, and in about thirty minutes the mass is ready to cut.

2. *Cutting.*—This coagulated mass is called the curd. In order to remove the water from the mass it is necessary to cut the curd into small blocks. This is done by knives specially made for the purpose. The cutting is done crosswise, length-

* Wing: *Milk and Its Products.*

wise, and horizontally. After the cutting the mass is agitated gently to keep the cut surfaces from uniting. The little blocks shrink rapidly and squeeze out the watery part. This is called *whey.*

3. *Cooking.*—The entire mass is now slowly warmed up to a temperature of 98° F. This has the effect of increasing the lactic acid and further shrinking the curd. During the heating the mass is stirred slowly and gently at first, but more vigorously later. When the mass has reached 98° F. stirring is stopped and some of the whey may be drawn off, but enough must be left to cover the curd. When the curd is tough enough to stick to a hot iron and pull out in fine threads a quarter of an inch long it is ready for the next step.

4. *Cheddaring, or Matting.*—The whey is now drawn off. The curd now mats, or cheddars, together in the cheese vat. When it is well matted it is cut into blocks about eight by eight by twelve inches. These blocks are piled two deep on top of each other, care being taken to put the outside faces inside. This helps the draining away of the whey. After a time the blocks are piled into larger piles, and later these into still larger piles, each time putting the outside surfaces inside. During this time the temperature is kept up in order to aid the production of lactic acid, which brings about various changes in the curd. The curd should now contain so much acid that threads two or three inches long will pull out when applied to a hot iron.

5. *Grinding.*—By this time the whey has been well drained away and enough lactic acid has been developed so that the curd is ready for grinding. This is done in order that the curd may be salted and pressed into the form of the cheese. The grinding is done with a special machine called a *curd-*

mill. The cut particles must be stirred to keep them from reuniting.

6. *Salting and Pressing.*—Salt is added mainly for its effect upon the flavor. It also aids in making the curd drier and harder. Coarse salt is better than fine salt. It should be uniformly distributed, and the curd stirred until the salt has dissolved. During this time the temperature has been kept up until, at the salting, the curd has a temperature of about 90° F. When the salt is added the curd is spread out and cools off to about 80° F.

The curd is now put into a press, of which there are various kinds. There is a *form* made of wood or metal into which the curd is put, after first lining it with cheese-cloth. There is a lid called the *follower* which fits just inside the form. The pressure is applied to this and it squeezes the curd into a compact mass. Pressure is kept up for twenty hours or more.

7. *Curing.*—When taken from the press the mass of curd is called *green* cheese and is now set away to cure. This is done on shelves in a room where the temperature is about 65° to 75° F. During the curing process many changes take place which develop the flavor and make the cheese digestible. In four to six weeks the cheese may be used, but it is better if more ripening is allowed, and will continue to improve up to three or four months, after which if it is kept in a cool place not too moist the cheese may be kept in good condition for a couple of years.

What has been said about the process of making cheddar cheese applies in a general way to the making of many other varieties. In all there are said to be over one hundred and fifty kinds of cheese manufactured in America and Europe. When a cheese contains a considerable quantity of water it

is known as a *soft* cheese. There are several varieties of this kind. The removal of most of the moisture makes a *hard* cheese, and this is the common kind. When a cheese is made from whole milk it is called a *full-cream* cheese; when made from skimmed milk it is known as *skim-milk* cheese; when made from skimmed milk or whole milk to which other fats than butter-fats have been added it is a *filled* cheese. In the manufacture of some kinds of cheese fermentation is allowed to take place until certain well-defined odors are noticeable. These are *fermented* cheeses. Limburger cheese is an example of this kind.

Although many kinds of cheese are made without especial attention to cleanliness, yet all that was said concerning care and cleanliness in handling milk, cream, and butter applies to the making of cheese, and especially American varieties.

Condensed Milk.—Condensed milk is milk from which most of the water has been evaporated. The milk is evaporated in copper vacuum pans by the use of steam. This reduces the bulk of the milk about two-thirds, but retains all of the solids. Condensed milk is put up either sweetened or unsweetened. It is used largely as a food for babies, but this use is not desirable unless cow's milk of good quality is not obtainable. Condensed milk is also used by confectioners, in lumber camps, on ocean liners, and by all travellers who have to carry their supplies with them. In the making of condensed milk the matter of cleanliness reaches its highest perfection.

There is also a product called *milk-powder*, made by evaporating milk to dryness.

Ice-Cream.—Ice-cream is made from rich whole milk or from rich cream. The latter is the better. Ice-cream consists

of milk or cream, sugar, eggs, flavor, and sometimes cornstarch or gelatine, prepared according to recipe, and frozen. There are many recipes; some require fewer than the above items, others more.

Renovated or Process Butter.—Renovated butter is made from bad butter which has been bought up by dealers. There are certain factories which take the poor butter and melt it, clarify it, aerate it, ripen it, and then churn it with a starter of fresh milk, cream, or skim-milk. They also remove the bad odors and color the butter attractively. For a time much of this worked-over butter was sold as creamery butter, a fraud, but now the law requires it to be plainly labelled "Renovated Butter," and also collects a tax on it. This is done in order to encourage the making of good butter.

CHAPTER XLIV

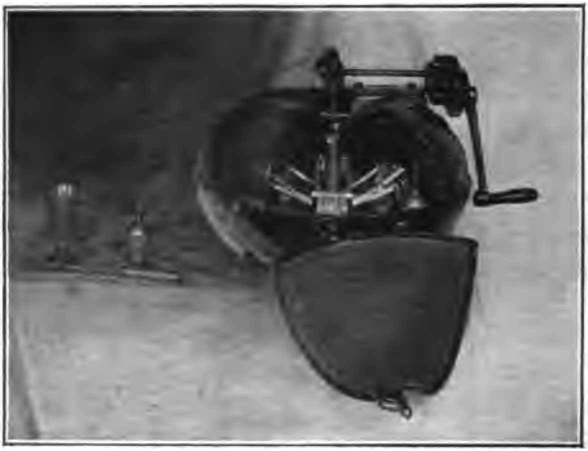
TESTING MILK

Milk is commonly tested for two purposes: (1) To determine whether or not it has been adulterated with water; (2) to determine the per cent. of butter-fat.

1. As was mentioned in a previous chapter, milk is heavier than water, ordinarily .032 heavier, that is, its specific gravity is 1.032. It is very rare for pure milk to have a specific gravity less than 1.029. If water has been put into milk to any extent, the specific gravity will go below 1.029. An instrument resembling a floating thermometer has been devised for determining the specific gravity of milk. This instrument is called a *lactometer*. The glass tube is graduated somewhat like that of a thermometer. There are two common forms of lactometers, the Board of Health lactometer and the Quevenne (Kwĭ-vĕn′) lactometer. These are graduated differently, but give the same results.

When the lactometer is put into the milk it will sink to a certain point. The Board of Health lactometer should not sink below 100, the Quevenne not below 29. Then by reading the figures on the glass tube one can tell the specific gravity of the milk and from these whether the milk is pure or not. It should be remembered that the lactometer test is not absolutely reliable, but in any case of doubt further investigation can be made.

Lactometers are made to use with the temperature of the milk at 60° F. For each degree above this .1 of a lactometer degree is added to the reading, or subtracted, if the temperature is below 60° F., when using the Quevenne lactometer. When using the Board of Health lactometer one degree of



76. A BABCOCK MILK TESTER AND TESTING OUTFIT

change is made for each three degrees of temperature. The temperature should never vary much from 60° F. for good results.

2. There have been several schemes devised for determining the per cent. of fat in milk, but at the present time there is practically but one used in this country. This is known as the Babcock test, and was invented by Dr. Babcock of the Wisconsin Experiment Station. In this test all the milk solids except the fat are dissolved by sulphuric acid, then by means of hot water and centrifugal force the fat is floated on the

surface of the fluid and read off in the graduated neck of a specially constructed glass bottle.

For making the test 17.6 cubic centimeters of milk is measured out with a marked pipette and put into a test bottle. (See Fig. 77 for the different articles used in making this test). Now 17.5 cubic centimeters of sulphuric acid is measured out and poured into the test bottle in such a way that it washes down any milk on the side of the neck and runs under the milk at the bottom of the bottle. The sulphuric acid curdles the milk at first, but the curdled part is soon dissolved. The sulphuric acid used must have a specific gravity of from 1.82 to 1.83.

After the acid has been added, the test bottle is shaken by hand with rotary motion. The bottle should be grasped by the neck near the bulb, and care should be taken not to shake any curd up into the neck. The mixing of the acid and milk creates a good deal of heat, and the test bottle becomes quite hot and the contents very black. When the shaking has gone far enough the curdled portion has all dissolved, and the contents are uniformly black with no fragments floating in it.

The test bottle along with others is now set in the pockets of the centrifuge and whirled at a speed of 900 to 1,000 revolutions per minute. Most of the small centrifuges are run by hand, while the large ones are operated by steam. The whirling is kept up steadily for five minutes. The revolving is then stopped and each test bottle is filled to the neck with boiling hot water. They are then whirled again for two minutes at the same speed. The machine is again stopped and the bottles filled with more hot water up to the 8 or 9 per cent. mark. Again they are whirled for one minute. The fat has now all collected into the neck of the bottle and stands out distinctly

from the rest of the contents and is ready to be read. The figures opposite the long marks indicate the per cent., while the short marks indicate tenths of one per cent. The reading is done by subtracting the figure at the bottom of the fat column from that at the extreme top of the column. A pair of dividers is useful to aid the eye in reading correctly. The reading should be done quickly while the fat is hot.

For the testing of cream a bottle with a large neck and graduated up to 35 per cent. or more is used. In the testing of cream 18 grammes is weighed into the bottles. For skim-milk and buttermilk a bottle with two necks is used. One is large, for putting the acid and milk into, and the other is quite small, and in this the fat gathers and is read off in hundredths of one per cent.

The taking of the sample for testing is a very important matter. In the case of whole milk it is best to take a sample as soon as the milk is drawn from the cow, and in that case the milk should be poured from one bucket to another two or three times in order to get it thoroughly mixed. If the milk has become cold and the cream has risen it will take a great deal of pouring and mixing to get the fat globules completely distributed again. The sample may be put into a small bottle. The sample for testing is taken from the larger sample by means of a pipette and put into the test bottle. The testing is done at convenience. The same care in mixing should be taken with cream or skim-milk.

If it is desired to get an average of the fat produced by a cow in a week, without testing each milking, a small sample is taken at each milking and put into a pint fruit-far. A bit of bichromate of potash or corrosive sublimate should be put into the bottle to keep the milk from souring. If it sours a fair

sample cannot be taken for testing. Such samples are called *composite* samples. They are tested at the end of a week and show the average per cent. of fat. The composite samples are used at creameries where each patron's milk is tested.

CHAPTER XLV

ABOUT BEES

It is hoped that every one who reads this chapter will try to find out more about bees than is told here. Bees are most interesting and valuable insects. Many a person has spent his entire life in studying bees and working with them. They have been kept, studied, and written about from the earliest times. Every one likes honey to eat, and every farm could easily support some bees and furnish the delicious food for the farmer's table.

Bees can be kept in various places. An orchard used as a sheep pasture is an ideal place for bees. The sheep will keep the grass short and the trees give shade. It is desirable to keep the grass or weeds from growing tall in front of the hive, as bees returning home heavily laden will become entangled in the tall grass and be unable to get into the hive. Bees have been successfully kept on the roofs of large buildings in cities. Many persons living in the city keep bees in their back yards.

When America was first colonized there were no honey-bees north of Mexico. The early settlers brought with them what are known as the black or German bees, and the wild bees now found are descendants from swarms which escaped. Some years ago bees from other countries were brought here. The Italian bees have met with the most favor. In fact,

scarcely any other kind is now kept. Some of the other races of bees are Cyprian from Cyprus; Syrian from the Holy Land; Egyptian from Egypt; and Corniolan from Corniola, Austria. The Italians are so much liked because they are gentle and do not often sting. When Italians become crossed with other races, the hybrids are usually very nervous and

77. LOCATION OF APIARY

The trees give shade and the fence and building protect from wind.

irritable. The Cyprians probably gather more honey than any other race. There is record of one colony of these bees having gathered one thousand pounds of honey in one season.

A colony or swarm of bees at the beginning of the honey season usually consists of 30,000 to 40,000 worker bees, a queen, and perhaps several hundred drones. Besides these there are several combs containing young bees not yet fully developed.

The honey-bee is developed from an egg just like other insects. (See Chapter XXVII.) The queen bee lays the egg in

the bottom of a six-sided cell. The egg hatches in three days; the larva is fed by the nurse bees for five days; then the larva turns to a pupa and remains in this condition for thirteen days; and at the end of twenty-one days from the laying of the egg the young bee comes out of the cell. In a couple of days it is ready to begin its life work. Queen bees hatch out

78. SHOWING QUEEN, WORKER, AND DRONE

in about sixteen days from the laying of the egg, while for drones the time is twenty-four days.

The worker bees compose the majority of the hive. The first work for the worker bee after it is developed is to act as a nurse and feed the other larval bees in their cells. The food consists of a kind of bee milk secreted from glands in the head of the nurse. On the third day honey is added, and a little later pollen, and at the end the larva receives practically nothing but pollen. After acting as a nurse for a week or

more, the young worker begins to take short flights outside of the hive, as though it were taking exercise. Finally, after a couple of weeks spent in learning household duties, the young bee begins field work in gathering nectar and honey. All worker bees are undeveloped females. The life of a worker is about one and a half to two months during the busy season, so the supply of workers must be constantly replenished.

The queen bee is hatched from the same kind of egg as the workers and is fed the same food at the start, but the rich bee milk is continued all through the feeding period, so that the queen larva grows larger and develops faster than the others. After she hatches out she runs about over the combs for exercise and looks for other queens or queen cells. If two queens meet there is a fight and it continues until one is dead. If other queen cells are found the larvæ are stung to death. After establishing her supremacy the queen bee leaves the hive to meet some male, a drone, in the open air. Mating takes place on the wing. After this marriage flight the queen returns to the hive, never to leave it again unless it be to go with a swarm. She sets to work at once laying eggs. She deposits a single egg at the bottom of each empty cell. In busy times a queen can lay as many as three thousand eggs in a day. A queen bee lives four or five years, but her greatest usefulness is during the first two or three years.

The drone is the male bee. There is usually a large number of these hatched during a season, although not nearly so many as there are of workers. The drone does no work. He is not fitted by nature for the carrying of pollen nor the gathering of honey, so he must live off the stores of the hive. This is permitted so long as the honey supply from flowers is

plentiful, but when this decreases the worker bees sting the drones to death and throw them out the door of the hive. The drone has no sting and cannot defend himself. It is said that the antennæ of the drone has 37,800 little smelling organs.*

Honey is made from the nectar of flowers, a drop or more of which is found in the base of the corolla of the flower. The

79. A MASS OF HONEY-COMB

bee sucks this into a honey sac inside its body and carries it to the hive where other workers take it, evaporate some of the water, add certain substances, and deposit it in the honey cells. These cells are not capped over as soon as they are full, but the honey is allowed to "ripen" first. A honey-bee will collect honey from flowers within a radius of two or three miles from the hive. If there are many flowers of the same kind in blossom at one time, the bees will collect from only

* Comstock: *How to Keep Bees.*

one kind while they last. In this way honey is made from the nectar of just one kind of flowers at a time, and we get sweet-clover honey, or white-clover honey, or buckwheat honey, according to the kind of flower drawn from. When there are only a few flowers of one kind the honey is made from the nectar of all kinds of flowers.

The worker also gathers the pollen from flowers into a

80. A MODERN BEE-HIVE AND ITS PARTS

"pollen basket" on her hind legs. This is carried to the hive and made into bee-bread and used for feeding larvæ.

Bees also gather a substance called "bee-glue" from the buds of trees. This "bee-glue" is properly called *propolis* and is used for stopping up holes or cracks in the hive. The whole inner surface of the hive is also coated over with this substance, and movable parts are stuck together with it.

The amount of honey which a swarm of bees will produce

in a season will depend largely upon the supply of flowers and the vigor of the swarm. A strong swarm in a good season will produce a surplus of 20 pounds of honey in the comb, or 30 to 35 pounds of *extracted* honey.* To extract honey, the combs are taken out, the caps carefully cut off the cells and then the decapped combs are whirled in a centrifugal machine called an *extractor*. The empty combs are then replaced in

81. AN APIARY IN WINTER QUARTERS

the hive and the bees can go to work filling the empty cells at once, thus saving the time of making new combs.

Almost any kind of empty box can be used for a bee-hive, but where bee-keeping is done properly modern hives are used. A good hive is a box-like affair with a removable top and bottom. An opening, a small slot, is made at the bottom in one side for the bees to enter. There should be a ledge by this opening for the bees to alight on when returning to the hive. Inside the box are hung frames containing

* Farmers' Bulletin, No. 59.

honey-combs. These the bees will use for storing honey and pollen, and for brood cells for the young larvæ. They will also build additional cells as needed. When these frames have become filled with honey and brood, a section called a *super* can be put on top of the main box and the top placed on it. This super may contain small frames which when filled

82. HIVING A SWARM OF BEES

will hold one pound of honey each. The bees soon begin to fill the frames in this super, and as soon as all frames are full the super can be removed and replaced by another. In removing these supers the bees are driven down into the lower box by smoke or are brushed off gently with a brush.

In cold climates bees will need some protection in winter. Frequently this is done by shedding over with boards and covering with cornstalks or straw, but professional bee-keep-

ers usually pack the hives inside a larger frame, or pack the top and sides with papers or straw matting. The doorway should always be left uncovered so that bees can get out on warm days. Some keepers store their bees in cellars or sheds. In spring all these coverings should be removed.

Usually in June, when the queen is very active in laying eggs, the hive gets so full of young bees that there is no longer room and *swarming* takes place. When a swarm comes out it usually settles on the limb of a tree near by, and if undisturbed after a time it will take flight and go away to some hollow tree or crevice previously determined upon. After a swarm has settled, a hive should be brought and placed near with a sheet under it. The limb should be cut off carefully and the swarm jarred off in front of the hive door. If the limb is near the ground it is not necessary to cut it. As soon as the queen enters the hive the rest follow and settle in their new home. The hive can later be removed to the place where it is to stand. The hive used should be cool, as bees will not enter a hot hive. There should be in the hive some frames containing empty comb for the bees to go to work on.

There is much more to be written about bees but it cannot be said here. One thing is to be kept in mind: bees should always be handled gently and without any show of fear. The Italian races of bees will rarely sting if carefully handled. Bee-keepers frequently wear veils and gloves to protect themselves while handling their bees.

CHAPTER XLVI

POULTRY

ORIGIN AND BREEDS OF POULTRY

THE term *poultry* is applied to chickens, ducks, geese, turkeys, guineas, and peafowls. While the last two mentioned are of very little importance, the other four are much more so than is generally supposed. The Secretary of the United States Department of Agriculture states that the value of the poultry and eggs produced on farms in 1907 was more than six hundred million dollars; also, that the poultry products are worth more than the wheat and perhaps as much as the hay raised in the United States.

Probably all kinds of poultry, with the exception of turkeys, had their origin in Asia. The so-called jungle fowl of India is thought to be the original of our chickens. Very much has been done by poultrymen in the production of new breeds and the improvement of old ones. Chickens have received more attention than ducks and turkeys, and geese have had scarcely any study.

Chickens.—In the revised edition of Farmers' Bulletin No. 51, it is stated that there are 104 standard varieties of chickens in this country. Besides these there are several miscellaneous varieties. A *standard* variety is one which conforms to the description of that variety by the American Poultry Association. Perhaps the best way to classify this

large number of varieties is as in the bulletin mentioned: 1. American. 2. Asiatic. 3. Mediterranean. 4. English. 5. Polish. 6. Dutch. 7. French. 8. Game and Game Bantam. 9. Oriental Game and Bantam class. 10. Ornamental Bantam class. 11. Miscellaneous.

These classes may also be arranged according to their usefulness, but in so classifying it is necessary to name individ-

83. PLYMOUTH ROCK COCK AND PULLET

ual breeds in some cases. The classes according to usefulness are as follows: 1. General purpose, including the American class, the Orpingtons, and Houdans. These breeds are both good egg and good meat producers. 2. The meat or table breeds, including the Asiatic class, the Dorkings, and the Indian Games. 3. The egg breeds, including the Mediterranean class, the Dutch class, and the Red Caps. 4. The ornamental breeds, including all the remaining classes and breeds.

1. The American class comprises the Plymouth Rocks, Wyandottes, Rhode Island Reds, Javas, Buckeyes, and American Dominique. There are two or three or more varieties each of most of these breeds, as, for example, there are six varieties of Plymouth Rocks, the Barred, Buff, White, Silver-pencilled, Partridge, and Columbian. Of this class the first three breeds are best known and most widely raised. There are probably more Plymouth Rock chickens raised than any other breed. The breeds in the American class are considered general-purpose breeds because they are all excellent layers and at the same time are good table fowls. The breeds in the American class are all of American origin.

84. A RHODE ISLAND RED

2. The Asiatic class contains the Brahmas, Cochins, and Langshans. Each of these breeds has two or more varieties. This class contains the largest breeds of chickens. They are more valued for their meat production than for their eggs, although they are fair layers. They are more inclined to brood than most breeds and make excellent mothers. Fowls of these breeds have their shanks and toes more or less covered with feathers.

3. The Leghorn, Minorca, Andalusian, Ancona, and

Spanish breeds belong in the Mediterranean class. These are of European origin, mostly from along the coast of the Mediterranean Sea. The Leghorn and Minorca families are best known and most widely distributed. The breeds of this class, and especially the Leghorns and Minorcas, are famous as egg-producers. Practically all of the breeds in this class lay white-shelled eggs, while the eggs of nearly all the breeds in the other classes have tinted shells. The Mediterranean breeds are smaller in size than any others, except those in Classes 8, 9, 10, and 11. They are non-sitters, that is, they rarely want to sit, and this is a desirable trait where one wants eggs.

85. BUFF COCHIN
Contrast the Cochin with Plymouth Rock and Rhode Island Red

4. The English breeds are the Dorkings, Red Caps, and Orpingtons. The Dorking is the oldest breed of chickens. These fowls have five toes on each foot, a condition not found in any other breed except the Houdan. The Red Caps are also an old breed. They have too large a comb to become popular as a farm fowl. They are good layers and their flesh is of excellent quality. They are non-sitters. The Orpington breed is one of the latest breeds, and because of its high quality as

an egg and flesh producer has gained a great reputation. In 1908 Madame Paderewski, wife of the famous pianist, paid Mr. Ernest Kellerstrass, of Kansas City, Missouri, $7,500 for five White Orpingtons. At the same time Mr. Kellerstrass refused $2,500 for a prize hen of this breed.

5. The Polish class is composed of one breed of which there are several varieties. This class probably had its origin in Poland. It is an ornamental rather than useful class, although Polish hens are fair layers. The head of both the hen and cock has a large crest, or top-knot, of feathers, so large oftentimes as to hinder the seeing of the bird.

86. PRIZE WINNING BROWN LEGHORN HEN

6. The Hamburg breed, of which there are six varieties, represents the Dutch class in this country. They are excellent layers and have become a popular breed.

7. The best-known of the French breeds is the Houdan. Besides the Houdan the Crevecœurs, La Fleche, and Faverolles belong to this class. All but the La Fleche are large. They are fair layers and good table fowls. The Houdans and Crevecœurs have crests.

8 and 9. The various breeds included in the game class are fair layers and good table fowls. Those known as Pit Game

are very well adapted to the farm. The Exhibition Games are considered not quite so good for the farm, not being hardy. The Game Bantams are simply dwarf Exhibition Games and are not profitable for the farm.

87. A BUFF ORPINGTON HEN

10. The Ornamental Games are of several varieties. They are kept mainly as pets and are not satisfactory as layers or table fowls.

11. The Miscellaneous class comprises several varieties little known in this country and kept mainly as curiosities. The Sultans have a remarkable crest. The Silkies have soft, loose, fluffy feathers standing out in all directions from the body. The feathers of the Frizzles curve upward and backward at the end and give the birds a very odd appearance.

Ducks.—It is said that more ducks are raised in China than anywhere else in the world and that the United States stands next to China in duck-production. There are ten standard varieties raised in the United States; namely, Aylesbury, Rouen, Pekin, Cayuga, Call, East India, Indian Runner, Blue Swedish, Muscovy, and Crested White. The last is mainly ornamental, the Call and East India are bantams, while the Pekin, Rouen, Indian Runner, and Aylesbury are

88. A PAIR OF PEKIN DUCKS

the most popular and profitable. The Pekin is the one mostly raised on the duck ranches. The Indian Runner duck is the best layer of the duck breeds and is being kept more and more for egg-production. It is thought that all breeds of ducks, except the Muscovy, originated from the wild Mallard duck. The Muscovy duck is quite distinct from all others and its origin is not definitely known, but is believed to have been in Peru. This breed is rather bad-tempered.

89. A TOULOUSE GANDER
First prize at Madison Square Garden, New York City, Poultry Show

Geese.—Geese have not received much attention by poultrymen and the different breeds are not very distinct. There are five popular breeds: Toulouse, Embden, Chinese, African, and Wild, or Canada, Goose. The last-named has not been fully domesticated and has to be kept confined. With the exception of the

Wild Goose, the different breeds of geese originated in the Old World. The Toulouse and Embden are most popular. The production of geese for commercial purposes is on the increase in the United States.

90. A BRONZE TURKEY

Turkeys.—The only domestic animal on the farm of strictly American origin is the turkey. There are three species of wild turkeys in America: 1. A species found mainly in the northeastern United States and now almost extinct. 2. A species in Mexico. 3. A species in Honduras and Central America. It is believed that the Mexican variety was carried to England and Spain by the early explorers and later brought back again by the early colonists. With these common turkeys the northern wild turkey interbred and from the cross the Bronze turkey was originated. This is the largest and most popular variety of turkeys. The other breeds are the Narragansett, Black, White Holland, Buff, and Bourbon Red. The last three are also popular and are valuable market birds.

Guineas and Peafowls.—The guinea came from western Africa. There are two varieties, the Pearl and the White.

The White is a sport from the Pearl. There is a growing demand for guineas in the markets of large cities to supply the demand for game birds. The guinea flesh has a flavor not easily distinguished from that of grouse or pheasant. A few guineas on the farm, by reason of the noise which they make, are a good protection from hawks and chicken thieves.

The Peafowl has no commercial value whatever and is kept entirely as an ornament.

CHAPTER XLVII

CARE OF POULTRY

1. **Hatching.**—The first step in the production of young poultry is to have fertile eggs. The best eggs for hatching are obtained in the spring months, as this is the natural mating season for birds. Eggs from birds which have plenty of range for exercising usually hatch better than those from confined birds. Proper feeding is also important, but this will be spoken of in another paragraph. In poultry-raising as with all other live stock, the breeding animals should be the best that can be had and they should be in perfect health.

There are two methods of hatching, the natural and the artificial. The *natural* method is the one commonly used on the farm and consists in giving eggs to the hen and allowing her to sit on them the necessary length of time. The period of *incubation* is as follows: chickens, 21 days; ducks, 26 days; geese, 30 days; turkeys, 27 to 29 days; and guineas 26 to 28 days. Fresh eggs will hatch a little earlier than eggs not fresh. The chicken hen is often used for hatching the eggs of the other kinds of poultry, although it is usually best to let the turkey hen hatch her own eggs.

Artificial incubation is done in an *incubator*. This is a specially constructed box having compartments into which the eggs are put. These are kept warm by an oil lamp. The temperature used is 103° F., this being the temperature of

a sitting hen. Incubators are of all sizes and are used mainly by persons raising poultry on a large scale. Directions for operating the incubator are always supplied by the manufacturer and should be closely followed.

In the natural method the little chicks are cared for and kept warm by the hen, but in the artificial method the young

91. AN INCUBATOR

chicks must be kept warm by an artificial mother, called a *brooder*. Brooders are variously constructed, but are usually of two parts, one warmed by an oil lamp, for sleeping, and another warmed by the sun through glass, for a runway. After the chicks are a few weeks old they can get along without extra heat. There has recently been invented a brooder known as the "lampless" brooder. It keeps the chicks warm

92. THE LAYING AND BREEDING HOUSE USED AT THE MAINE EXPERIMENT STATION FOR EXPERIMENTAL WORK WITH POULTRY

By courtesy of the Maine Experiment Station

without artificial heat and is being used successfully by many poultrymen.

2. **Housing.**—All kinds of poultry do best when they have full liberty, as this is their natural state, but it is often necessary to keep them yarded. In such cases there should be many yards and few fowls in a flock. Not more than 25 chickens should be kept together, and 15 is a better number. A house having a floor measurement of 10 by 12 feet and a runway of 20 by 100 feet is desirable for such a flock. In locating houses and yards one should seek a southern exposure. This gives the largest amount of sunshine and shields somewhat from the winds. The houses and yards should have good drainage and be kept thoroughly clean. It is difficult to keep chickens that are penned up free from lice. Dusting-boxes filled with road dust should be provided. A large box accommodating several hens at a time is best. The hens should also be dusted with insect powder occasionally. During the summer, if hens have freedom, they will provide their own dusting-places, but in winter even free hens should have a box of dust.

The chicken mite is also a troublesome insect. Unlike the louse, the mite stays on the roosting-place in the daytime and feeds on the bodies at night. Painting the roosts with some one of the coal-tar dips will destroy the mite.

3. **Feeding.**—In the feeding of poultry, as in the feeding of other live stock, the general principles mentioned in the chapter on Feeding apply. Young birds and laying hens need a ration with a narrow nutritive ratio, while fattening birds require a ration having a wide nutritive ratio. Laying hens should have grain, vegetables, and animal food. During summer, if they have freedom, the hens will supply their own

vegetable food from the grass and their animal food from the insects which they can catch. Some mixed grain consisting of corn, kafir corn, and millet seed should be fed in addition. In winter the vegetables can be supplied from cabbage and beets and the animal food from beef scrap. The grain feed in winter can be largely of corn, but wheat screenings, kafir corn, oats, and millet seed should also be given. During cold weather a mash made from equal parts of corn-meal and

93. THIS DOZEN OF BLACK MINORCA EGGS WON THE FIRST PRIZE AT THE LEBANON, IND., EGG SHOW, 1908. THEY WEIGHED 32½ OUNCES

wheat bran and a small quantity of beef scrap is a good feed for morning. All poultrymen prefer to feed grain in the evening. For hens kept in confinement such food as they could get when running at large should be supplied as fully as possible. Confined hens should have access to plenty of sand and gravel. Ground oyster-shells and cracked charcoal are also essential. Hens running at large can supply themselves with grit, but the oyster-shells and charcoal should be at hand for them also. When grain is fed it should be thrown into straw or leaves, especially in winter, so that the hens will have to scratch for it. This gives them exercise and warms them up. Fresh and clean water is one of the

most essential things for laying hens. It is surprising how much water hens drink when they can get it. Skim-milk is excellent. It may be said in this connection that hens which have plenty of exercise rarely get too fat to lay. A poor hen never lays eggs. Unless a hen is well fed she should not be expected to lay eggs.

During the autumn months, usually September and October, chickens *moult*, that is, shed their feathers and get new ones. At this time hens do not lay eggs, but they should be carefully fed just the same. Plenty of green feed should be given; also, beef-scrap, meat, or green ground bone. It is desirable to get them through the moulting season as soon as possible so that they will begin laying eggs. Eggs at this season always command a high price.

The sitting hen is put to a severe strain to provide the necessary heat for keeping her eggs at the proper temperature and she needs food which is heat-producing, that is, food having a large proportion of starch and fat. Corn is one of the best feeds. Other feeds should also be supplied. Plenty of clean water, grit, and dust should be provided.

Poultrymen have different opinions as to the best method of feeding young chicks, but all agree that no feed should be given for thirty-six hours after the chick is hatched. When the chick is hatched its digestive tract is full of the yolk of the egg, and this supplies its wants for some time. Some poultrymen would give as the first feed something soft, like corn-meal wet; others prefer dry feed, like mixed grains cracked fine, or dry rolled oats. In a few days small grains and cracked corn can be fed. Whole wheat, cracked corn, and skim-milk are standard feeds for young chicks. As soon as "feathered out," they can be fed much the same as mature

chickens. Of course, plenty of water, grit, and charcoal are necessities.

The natural food of ducks is vegetable and animal and always in the soft state. The duck has no crop and the food passes directly to the gizzard. Food for young ducklings at first should be cracker or bread crumbs and corn-meal moistened. In a few days a mixture of bran, corn-meal, rolled oats, and beef scrap may be given. Some sand may be mixed with the feed to good advantage. Green feed like grass and clover should be plentifully supplied. Ducks will do well without water to swim in.

Goslings also require soft feed. Their first food should be grass, fed on the sod;* then corn-meal, moistened, with a little sand and charcoal mixed in. After the goslings are four or five days old they can be allowed to roam where they will, but they should continue to receive soft food like corn-meal and wheat bran mixed and cooked. Geese are naturally grass-eaters, and a pasture or orchard is where they do best. A patch of rape is most excellent for geese. So also is clover.

Young turkeys are very delicate and must be carefully protected from wet grass and rain until they are about six or seven weeks old. Soft feed is best also for young turkeys. Stale bread or corn bread dipped in milk is excellent. When the grass is dry they should have plenty of range to catch insects. After they are six weeks or more old they can eat anything that is good for chickens. Turkeys need plenty of range to do well.

One thing should be kept in mind concerning the feeding of all young poultry—*the feed should be fresh and free from all sourness.*

* Farmers' Bulletin No. 64.

APPENDICES

APPENDIX A

FEEDING STUFF	Dry Matter and Digestible Food Ingredients in 100 Pounds of Feeding Stuffs *				Fertilizer Ingredients in 100 Pounds of Feeding Stuffs †		
	TOTAL DRY MATTER	PROTEIN	CARBOHYDRATES	FAT	NITROGEN	PHOSPHORIC ACID	POTASH
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Green fodders:							
Rye	23.4	2.05	14.11	0.44	0.32	0.17	0.60
Oats	37.8	2.44	17.99	0.97	0.72	0.19	0.56
Timothy, at different stages	38.4	2.01	21.22	0.64	0.48	0.26	0.76
Kentucky blue-grass	34.9	2.66	17.78	0.69			
Red clover, at different stages	29.2	3.07	14.28	0.69	0.54	0.12	0.67
Crimson clover	19.3	2.16	9.31	0.44	0.47	0.12	0.39
Alfalfa, at different stages	28.2	3.89	11.20	0.41	0.58	0.12	0.50
Cow-pea	16.4	1.68	8.08	0.25	0.47	0.13	0.46
Soy-bean	28.5	2.79	11.82	0.63	0.63	0.14	0.56
Rape	14.3	2.16	8.65	0.32	0.35	0.12	0.62
Corn silage	25.6	1.21	14.56	0.88	0.33	0.12	0.36

* Farmers' Bulletin No. 22, revised edition. By courtesy of the Office of Experiment Stations.

† *Vorhees' Forage Crops.* By courtesy of the Macmillan Co.

Dry fodders and hays:							
Corn fodder, field cured	57.8	2.34	32.34	1.15	0.78	0.28	1.00
Corn stover, field cured	59.5	1.98	33.16	0.57	1.04	0.29	1.40
Kafir corn stover, field cured	80.8	1.82	41.42	0.98			
Oats hay	84.0	4.07	33.35	1.67	1.87	0.65	1.90
Orchard grass	90.1	4.78	41.99	1.40	1.07	0.33	1.62
Red top	91.1	4.82	46.83	0.95	1.07	0.33	0.95
Timothy (all analyses)	86.8	2.89	43.72	1.43	1.08	0.35	1.34
Kentucky blue-grass	78.8	4.76	37.46	1.99	1.20	0.39	1.54
Mixed grasses and clover	87.1	6.16	42.71	1.46	1.41	0.27	1.55
Red clover	84.7	7.38	38.15	1.81	2.09	0.43	2.08
Alsike clover	90.3	8.15	41.70	1.36	2.04	0.51	1.12
White clover	90.3	11.46	41.82	1.48	2.25	0.25	1.06
Crimson clover	91.4	10.49	38.13	1.29	2.48	0.62	2.11
Alfalfa	91.6	10.58	37.33	1.38	2.66	0.54	2.46
Cow-pea	89.3	10.79	38.40	1.51	2.48	0.66	2.36
Soy-bean	88.7	10.78	38.72	1.54	2.32	0.67	1.08
Straw:							
Wheat straw	90.4	0.37	36.30	0.40	0.43	0.13	0.74
Rye straw	92.9	0.63	40.58	0.38	0.50	0.29	0.79
Oats straw	90.8	1.20	38.64	0.76	0.65	0.22	1.22
Soy-bean straw	89.9	2.30	39.98	1.03	0.69	0.25	1.04
Roots and tubers:							
Potatoes	21.1	1.36	16.43	—	0.29	0.08	0.51
Beets	13.0	1.21	8.84	0.05	0.24	0.09	0.44
Mangel-wurtzels	9.1	1.03	5.65	0.11	0.19	0.06	0.46

APPENDIX A—Continued

	Dry Matter and Digestible Food Ingredients in 100 Pounds of Feeding Stuffs *				Fertilizer Ingredients in 100 Pounds of Feeding Stuffs †		
FEEDING STUFF	TOTAL DRY MATTER	PROTEIN	CARBOHYDRATES	FAT	NITROGEN	PHOSPHORIC ACID	POTASH
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Roots and tubers—Continued:							
Turnips	9.5	0.81	6.46	0.11	0.17	0.12	0.38
Ruta-bagas	11.4	0.88	7.74	0.11	0.19	0.12	0.49
Carrots	11.4	0.81	7.83	0.22	0.16	0.09	0.46
Grains:							
Corn-meal	85.0	6.26	65.26	3.50	1.44	0.63	0.37
Corn and cob meal	84.9	4.76	60.06	2.94	1.38	0.56	0.46
Ground corn and oats, equal parts	88.1	7.01	61.20	3.87			
Pea meal	89.5	16.77	51.78	0.65	4.39	0.91	0.99
Mill products:							
Corn (average of dent and flint)	81.1	7.14	66.12	4.97	1.48	0.61	0.36
Kafir corn	87.5	5.78	53.58	1.33			

* Farmers' Bulletin No. 22, revised edition. By courtesy of the Office of Experiment Stations.

† *Vorhees' Forage Crops.* By courtesy of the Macmillan Co.

Barley	89.1	8.69	64.83	1.60	1.51	0.79	0.48
Oats	89.0	9.25	48.34	4.18	1.81	0.77	0.57
Rye	88.4	9.12	69.73	1.36	1.62	0.81	0.52
Wheat (all varieties)	89.5	10.23	69.21	1.68	1.73	0.96	0.35
By-products:							
Gluten meal, Chicago	90.5	33.09	39.96	4.75	5.74	0.34	0.06
Gluten feed, Buffalo	91.0	22.88	51.71	2.89			
Hominy chops	88.9	8.43	61.01	7.06			
Brewers' grains (wet)	24.3	4.00	9.37	1.38	1.02	0.26	0.03
Brewers' grains (dry)	92.0	19.04	31.79	6.03	4.11	1.01	0.08
Distillery grains (dry) principally corn	93.0	21.93	38.09	10.83			
Distillery grains (dry) principally rye	93.2	10.38	42.48	6.38			
Wheat bran, all analyses	88.5	12.01	41.23	2.87	2.56	2.92	1.57
Wheat middlings	84.0	12.79	53.15	3.40	2.85	1.87	0.94*
Wheat shorts	88.2	12.22	49.98	3.83			
Cotton-seed meal	91.8	37.01	16.52	12.58	7.14	3.09	1.82
Linseed meal, old process	90.8	28.76	32.81	7.06	5.43	1.88	1.31
Linseed meal, new process	90.1	30.59	38.72	2.90	5.70	2.16	1.49
Milk and its by-products:							
Whole milk	12.8	3.38	4.80	3.70			
Skim milk, from setting	9.6	3.10	4.61	0.90			
Skim milk, from separator	9.4	3.01	5.10	0.30			
Buttermilk	9.0	2.82	4.70	0.50			
Whey	6.2	0.56	5.00	0.10			

* Brown middlings.

APPENDIX B

REFERENCE BOOKS

For more extended information on the topics discussed in this book, the following authorities may be consulted, all of which and many more were used in the preparation of this work:

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The Pruning Book—L. H. Bailey, Macmillan Co.
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ANIMAL HUSBANDRY

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CYCLOPEDIAS

Cyclopedia of American Horticulture, 4 Vols.—L. H. Bailey, Macmillan Co.
Cyclopedia of American Agriculture, 4 Vols—L. H. Bailey, Macmillan Co.

Farmers' Cyclopedia of Agriculture—Wilcox and Smith, Orange Judd Co.

Also, consult the various bulletins of the State Experiment Stations and of the United States Department of Agriculture.

APPENDIX C

EDUCATION AND AGRICULTURE

READING

READING stands first in the course of study because it furnishes the key that unlocks the door to so many subjects. Its work is interpretation, which may be merely mechanical or deeply significant. The child comes to school with an ear vocabulary, and reading must help him translate this into an eye vocabulary. This is the mechanical side of the subject and is merely the means to the real end. The printed words that he learns must become the symbols of deeply significant ideas. Indeed, reading pushes naturally over into the realm of art, and interpretation includes an appreciation of the harmony existing between the truth expressed and the form of its expression. The justification of the use of high-grade literature in our readers is found here.

The teacher is reminded that here the every-day experiences of the child with all his imagery must be employed in the interpretation. The child's world must furnish the basis of his choice in reading. The end is to train the child to read understandingly and, when he reads orally, in a way to be understood. The ability to read is the most essential of all the tools that the school furnishes. There are two phases of reading which must be emphasized, each of which may be closely related to the life of the child on the farm. In the

first place, the teacher may set it down as unqualifiedly true that the child cannot be taught to read from a text-book alone. Natural expression can come only out of his own life. The child in the first and second grades must furnish his own reading lesson out of the abundance of his own experiences and he must tell it in his own way. If he feels that he has the complete sympathy of the teacher, he may give the fullest, most natural expression to some childish experience, and when the teacher has written his story on the board may be made to realize that the language is the symbol of his actual experience.

The assignment, therefore, must find its first subject-matter in the child's world. Then, after the child has learned to read, and has become mature enough to read real works of literature, the teacher should still make his choice of reading-matter reflect the life of the child. The poetry of nature and the prose of farm and field should be chosen in part, at least, because in these the child will find himself and will realize that his world is recognized. The country boy and girl possess the imagery with which to interpret Shakespeare, Wordsworth, Gray, Thomson, Burns, Bryant, and Whittier. It is their

> "Knowledge never learned of schools
> Of the wild bee's morning chase,
> Of the wild flower's time and place,
> Flight of fowl and habitude
> Of the tenants of the wood"

that makes it possible for them to appreciate the beauty of the masterpiece at its full value.

Whittier's "Barefoot Boy" is a good type of the material that should be used in the reading work of the country school.

In assigning it the teacher should try to use the fullest experience of the children in its interpretation. Some such points as the following may be emphasized:

Read the whole poem. What is the principal thought running through it? Do you think Whittier had experienced what he is talking about? Why do you think so? Indicate the parts of the poem which describe experiences you have had. Classify each experience under the sense through which it came. Which experiences are most vividly portrayed? Through which sense did these come? Do you like the poem? Indicate the parts you like best. Try to tell why you like these particular passages.

It is said that farmers have no sense of the æsthetic; that they look on the daisy and the vine merely as troublesome weeds. If this is true it ought not to be so, because outdoor beauty may be counted as one of the chief assets of country life. In developing a love for nature the rural school has a decided advantage over the city school.

SPELLING

SPELLING CANNOT BE TAUGHT INCIDENTALLY. IT MUST HAVE THE SYSTEMATIC ATTENTION OF THE TEACHER AS A SEPARATE SUBJECT AND HIS CONSTANT CARE IN ALL HIS WRITTEN WORK. While oral spelling is helpful in fixing forms, written spelling must receive the larger stress because of its importance in writing the language. The eye rather than the ear must be trained. Constant drill in writing the correct form of a word serves to fix it in the mind.

The life of the children should supplement the Spelling-Book in the matter of spelling lessons. Each community has

its own vocabulary. There is a farm vocabulary, and it is essential that the children should learn to use it accurately and intelligently. The home life should dictate the point of departure, and the community vocabulary should be utilized. The assignments may from day to day call for lists of ten or twenty words covering the entire range of life in the community. The teacher may ask the class to hand in a list of ten words that are names of kitchen utensils. Suppose there are five children in the class and the teacher finds that twenty different words have been named. Such a device furnishes the fairest test of the child's ability to spell these words because he suggests them to himself and is not aided by having them pronounced. The teacher should correct the lists and hand them back. Then the list of the twenty different words should be used as a spelling lesson and made a part of a permanent list, the words in which are not to be repeated in the future exercises of making a community vocabulary. Then, in turn, lists in other of the home departments, lists in all the industrial departments covering every phase of farm life, lists covering the vocabulary of the social, the civil or governmental, the religious, and the school life of the community should be made. Spelling may thus become a usable tool for the child.

The assignment may take another form and accomplish the same purpose. Suppose the teacher has it in mind to teach inductively the definition of synonym. He may write the following assignment on the board:

Farmer; grower; cultivator; agriculturist; husbandman.

1. Pronounce these words.
2. Give the meaning of each.
3. Use one of these words in a sentence.

4. Substitute as many words as possible for this word in this sentence.

5. Upon what basis may these words be classified?

6. Think of a name or word that appropriately expresses words classified on such a basis.

7. State what is meant by such words.

The following group of farm words could be used in the same way: Cultivate, till, prepare, work, manure, plow, dress, sow.

The teacher may ask the class to write and use in sentences the names of all the parts of the reaping-machine. Or the teacher may suggest the following list and ask the class to use the words properly in sentences: Reaper, harvester, knife, finger, finger-bar, rake, reel, platform, dropper, binder, wire, twine, arm, sheaf, grain, bundle. The spelling work must be made to mean something.

ARITHMETIC

The main objects to be secured in the study of arithmetic are the ability to think number; the acquisition of skill, rapidity, and accuracy in the use of numbers required in ordinary business transactions; and the development of power in the application of the processes to the solution of all classes of problems. While the importance of this subject in the elementary school should be emphasized, it should not be so exaggerated as to deprive other subjects of their due share of attention. The work should be made intensive rather than extensive; the number of topics should be diminished and greater stress put upon those that are studied.

In teaching arithmetic the work should be made as concrete as possible. The problems in the book may be supple-

mented by the introduction of a large number bearing upon the environment and interests of the pupils. The household, the farm, the shop, the market, the trade, will furnish material, and the prices and conditions should be the real ones rather than the fancied ones of the books. The teacher should take from the actual business world, the tax office, the bank, the insurance office, the store, actual business transactions and make these the basis of the problems used. The actual market-price of a commodity with the actual amount bought and sold by an actual person will give reality to a problem.

In studying arithmetic the pupil should count the things at hand rapidly and accurately. The trees in a certain space, the rows of corn in a field, the number of shocks of wheat or corn, the number of rows on an ear of corn, the number of grains in a row and on the ear, the number of pupils in a row of seats, the number of rows, the number of pupils in the room, the number in the building—all objects at hand should be used. The very fact that they are at hand, and that the pupil is doing the work with them, will lend interest to the study.

The same material and data used in counting may be used in teaching addition, subtraction, multiplication, and division. The child ought to be led to discover that these processes are quicker than counting and why this is so. In a room with so many rows of seats, and so many seats in a row, he ought to discover shortly the way to find the whole number of seats without counting them. He should be led to make a map or plot of the room, of the corn field, of the wheat field and its shocks; he should measure accurately the schoolhouse, the home, the field, and the farm. He should find out by actual work how corn, and wheat, and potatoes, and hay

are measured and sold, and what is the actual selling-price from day to day. He should find out about butter, and eggs, and wool. Let him discover which would be fairer, to sell eggs by the dozen or by the pound. Let him find out how much corn the soil in his school district will produce to the acre, how many acres were in corn last year, and how much corn was produced.

Nor is it a boy's problem alone. There are quarts of milk and pounds of butter, and yards of goods, and curtains and carpets and scores of things for the practical housekeeper to know about. These actual numbers that the children have counted and collected and experienced are alive to them, and can be used in every step in arithmetic. As the work advances it should be made more and more constructive. Every principle should have concrete application. Actual fields should be measured by actual chains and plotted accurately to a definite scale. Actual fields of wheat and oats and corn should be estimated, and actual bins should be measured to determine their capacity. At every step of the way the pupil should be led to construct his problem and to look at actual conditions. The things at hand in every community, the occupations that are dominant, the interests that are prominent,—these are the means of education.

It is not a question of teaching arithmetic in the abstract, but of teaching particular children arithmetic in the concrete. The problem is not to instruct in arithmetic; it is to teach children with this setting to think number accurately and rapidly, and to apply principles under actual conditions. With this idea the text with its pages and problems disappears and in its stead come fundamental arithmetical principles which the teacher is to lead the children to master.

The child thus becomes the determining factor at every step of the way. It is upon what he can furnish as a basis of interpretation that the teacher must depend. In making his assignments in arithmetic, then, the teacher will see to it that the child always finds himself in these assignments.

Some members of the class may be assigned special problems more or less closely related to the principle in question. The following are suggested: (1) On October 6, 1907, hogs were quoted in the Chicago market at $6.60 a hundred; they showed an average daily decline of 7 cents a hundred between October 6 and November 25; what was the quotation on November 25? (2) What per cent. of the original price was the decline? (3) I found the length of a fence around a lot to be four miles, 100 rods, and 4 yards; counting each step that I took in measuring the fence 27 inches, how many steps did I take? (4) From November 15 to November 30, John's cow gave 63 gallons and 3 quarts of milk; what was the daily average? (5) If a pint of milk weighs a pound, how many pounds of milk does John's cow give in a day? (6) Is the quantity of milk John's cow gives above or below the average for a good cow? Base your answer upon actual data. (See Bulletin No. 127, Indiana Experiment Station.)

For the class in percentage the following problems are suggested as a type for supplementary work: (1) If a farmer in Alabama increased his acreage yield of sweet potatoes from 35 bushels to 250 bushels, what was the per cent. of increase? (2) In a space for a shock of corn 12 by 12 hills there are 420 stalks of corn; 21 stalks had no corn in them—*i. e.*, they were sterile; what per cent. of the stalks yielded corn? (3) With a loss of 10 per cent. from sterile stalks the yield is 63 bushels per acre; what would the yield have been with no

sterile stalks? (4) With corn at 40 cents a bushel, what was the loss in money? (5) Select 10 ears of corn November first and weigh them; weigh them again the first week in January, the first week in March, and the first week in April; compute the per cent. of loss at each weighing. (6) If corn can be marketed in the fall at 35 cents a bushel, would it pay to keep it till March and sell it for 40 cents a bushel? Why? (7) What per cent. do potatoes lose from digging time to the first of April? In making a test see if varieties differ. (8) A cow gives 625 pounds of milk a month; the milk tests 3.9 per cent. butter-fat; how many pounds of butter-fat were produced?

GEOGRAPHY

During the first three years no text is used in geography. However, no subject in the school course lends itself more completely to expression and construction in teaching than geography. The material is at the very door of the school-house in abundance. Hills and valleys, springs, brooks and rivers, capes, bays, peninsulas and islands, flora and fauna, the hand of nature and the hand of civilization, the book of geography is open for him who can read. If the teacher has SEEN, the joy of making the children see awaits him. If he has NOT SEEN, all this wealth is a closed book.

The central thought in geography is location. The law of distribution is the significant thing. One of the most important things is to get right notions and impressions regarding direction and distance, and with it to be able to read maps. The best way to get such right notions and images is through constructive work in early childhood, and the best place is the school-house, with its environment. First, make a map of the school-house, plotting it accurately, with one-

eighth or one-fourth of an inch to the foot as the scale. Locate accurately everything in the room. Next, make such a map of the school grounds. Extend the work to the district, and locate hills, valleys, streams, farms, houses, accurately. Study all farms at first hand and put them in their proper places. With all this the child will be prepared to answer intelligently how these farms came to be where they are and the effect their location has had on the life about them. With such constructive work at home the child will have a basis for comprehending the larger world. This constructive work could not begin before the third year, probably, and could not be completed before the eighth. The one thing the teacher needs to do is to make an intelligent use of the material at hand.

This method places much emphasis upon the use of the neighborhood for developing geographical notions. This is the centre of the child's world, and the work in geography should begin here instead of in some far-off place. The things close at hand should become a help in the interpretation of earth facts farther removed. The data at hand must suggest when to begin. Select the best types and make the assignment definite and exhaustive. Perhaps there is a good type of spring at hand. Lead the pupils to see all the conditions present. See if they can formulate a spring theory. See if they can think of other conditions than those present from which a spring might be formed. Does the spring here have an outlet? What becomes of the spring thus formed? Perhaps the spring has no visible outlet. What then?

The district or community may furnish other types of springs. If so hunt them up with the children. The point is to have these earth facts teach a complete lesson. It will take

time, but if every child can be led to see the facts at hand and from them to draw sound conclusions he will have begun to think. One such lesson is worth more in his education than mechanically memorizing the whole text in geography would be.

EXCURSIONS

This kind of instruction, and, in fact, much of the later study of geography, requires an occasional excursion. Yet it is well to keep in mind that properly conducted excursions require an unusual degree of energy and skill on the part of the teacher. The children may easily mistake such an outing for a picnic, and thus bring disaster to the teacher and to the cause. On the other hand, the ability to conduct an excursion well is one of the best tests of an able teacher.

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